VOLUME 4, NO. 8
AUGUST 1972

THE SHOCK AND VIBRATION DIGEST

A PUBLICATION OF
THE SHOCK AND VIBRATION
INFORMATION CENTER
NAVAL RESEARCH LABORATORY
WASHINGTON, D. C.

OFFICE
OF THE
DIRECTOR
OF DEFENSE
RESEARCH
AND
ENGINEERING

THE SHOCK AND VIBRATION DIGEST

Volume 4 No.8
August 1972

STAFF

A Publication of

THE SHOCK AND VIBRATION INFORMATION CENTER

Code 8404 Naval Research Laboratory
Washington, D.C. 20390

Robert Belsheim
Director

Henry C. Pusey
Coordinator

Edward H. Schell
Coordinator

Rudolph H. Volin
Coordinator

The Shock and Vibration Digest is a monthly publication of the Shock and Vibration Information Center. It carries current abstracts of interest to the shock and vibration community, book reviews, feature articles and news items. News items and articles to be considered for publication should be submitted to:

R. Eshleman
IIT Research Institute
10 West 35 Street
Chicago, Illinois 60616

Copies of articles abstracted are not available from the Shock and Vibration Information Center (except for those generated by SVIC). Inquiries should be directed to library resources, authors, or the original publishers.

This periodical is for sale on subscription at an annual rate of $25.00. Subscriptions are only accepted for the calendar year, beginning with the January issue. Back issues are available at the following rates: Volume 1 (1969) $5.00; Volume 2 (1970) $7.50; and Volume 3 (1971) $10.00. Orders may be forwarded at any time, in any form, to SVIC, Code 8404, Naval Research Laboratory, Washington, D. C. 20390. Issuance of this periodical is approved in accordance with the Department of the Navy Publications and Printing Regulations, NAVEXOS P-35.

EDITORS RATTLE SPACE

DR. MUTCH RETIRES

Dr. William W. Mutch, who served as head of the Shock and Vibration Information Center (SVIC) for 14-1/2 years, retired from government service on 30 June 1972. During this time while the application of shock and vibration technology was in its growth stages, SVIC served as a focal point for the dissemination of information. Many successful symposia were conducted by SVIC where a forum for communition of ideas and practice was provided. In fact the annual Shock and Vibration Symposium remains the gathering place for shock and vibration engineers. This publication of the SHOCK AND VIBRATION DIGEST, was initiated and evolved to its present form of providing an efficient means of communicating the vast literature to shock and vibration engineers under the directorship of Dr. Mutch.

Dr. Mutch succeeded Dr. Elias Klein, the first director of SVIC, who served for 11 years, Dr. Robert Belsheim of the Naval Research Laboratory succeeds Dr. Mutch. Dr. Belsheim, who is a noted structural dynamist, will insure the continued support of SVIC users in matters of shock and vibration technology. In addition, I am sure that Dr. Belsheim will continue the growth of SVIC with expanded services for its users.

In his retirement, Dr. Mutch will continue to be active in the matters of SVIC and will remain an editorial advisor to the DIGEST. On behalf of the DIGEST staff, I wish to extend to Dr. Mutch all good wishes for a pleasant retirement with many years of continued good health.

R. E.

INTERNATIONAL STANDARDIZATION -- MECHANICAL VIBRATION AND SHOCK*

by Bernard Fishman**

International standardization in the field of mechanical vibration and shock is being carried out within the International Organization for Standardization (ISO) by Technical Committee No. 108. The American Society of Mechanical Engineers (ASME) is responsible for coordinating this activity on behalf of the American National Standards Institute (ANSI). Thirty-five countires are involved in the work of TC 108, which is organized into 4 subcommittees and 21 working groups covering major areas such as balancing, measurement, test equipment, and human exposure.

The ISO (Fig. 1) is a body which was established in 1946 with the purpose of "promoting the development of standards in the world with a view to facilitating the international exchange of goods and services." The ISO is concerned with all areas of standardization, except electrical, the latter being dealt with by the International Electrotechnical Commission (IEC).

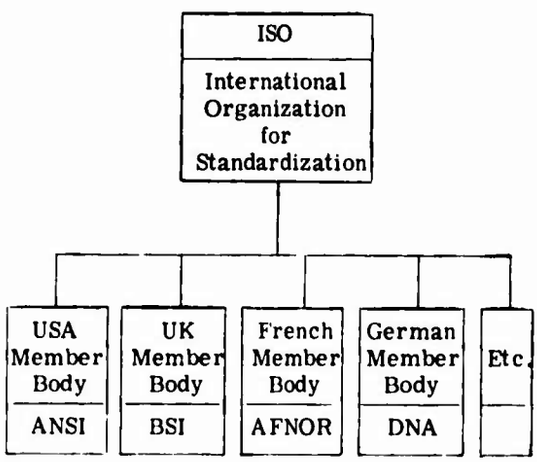

FIG. 1 TOTAL NUMBER OF MEMBER BODIES, 56

*Presented at the meeting of the Institute of Environmental Sciences, New York, N.Y., 2 May 1972

**Manager of International Standards and Research at the American Society of Mechanical Engineers.

The member bodies which belong to the ISO are the nationally recognized standardization bodies in each of the member countries. Thus, ANSI is the ISO member body in the USA; in the United Kingdom the member body is the British Standards Institution (BSI); in France it is AFNOR; and in Germany it is DNA. Altogether, there are 56 member bodies from different countries which belong to the ISO.

How does the ISO prepare standards? Different technical committees have been established to prepare standards in various areas of technology, some of which are indicated in Fig. 2. The first one established was Technical Committee No. 1 on Screw Threads, and we refer to this committee as TC 1. There are presently 148 technical committees, with the committee on mechanical vibration and shock, TC 108, having been established in 1963 at the proposal of the USA. All of the technical committees indicated in Fig. 2 maintain liaison with TC 108 because of their related interest in mechanical vibration and shock.

In order to coordinate the activities of each technical committee, one member body is designated to serve as the Secretariat. The responsibility for TC 108 has been assigned to ANSI. The ASME acts on behalf of ANSI in carrying out these Secretariat activities. The International Chairman of TC 108 is Professor Douglas Muster of the University of Houston.

Which countries are involved in the work of TC 108? Figure 3 shows the 35 countries which are presently concerned with the work of TC 108. Those which are actively involved are designated as participating or P members; there are 15 such countries at present. Those which have expressed an interest in only being kept informed of the work being done are designated as observer or O members; there are 20 who are presently listed in this category.

As can be seen from Fig. 4, the scope of work of TC 108 has been made sufficiently broad to permit its involvement in essentially all areas

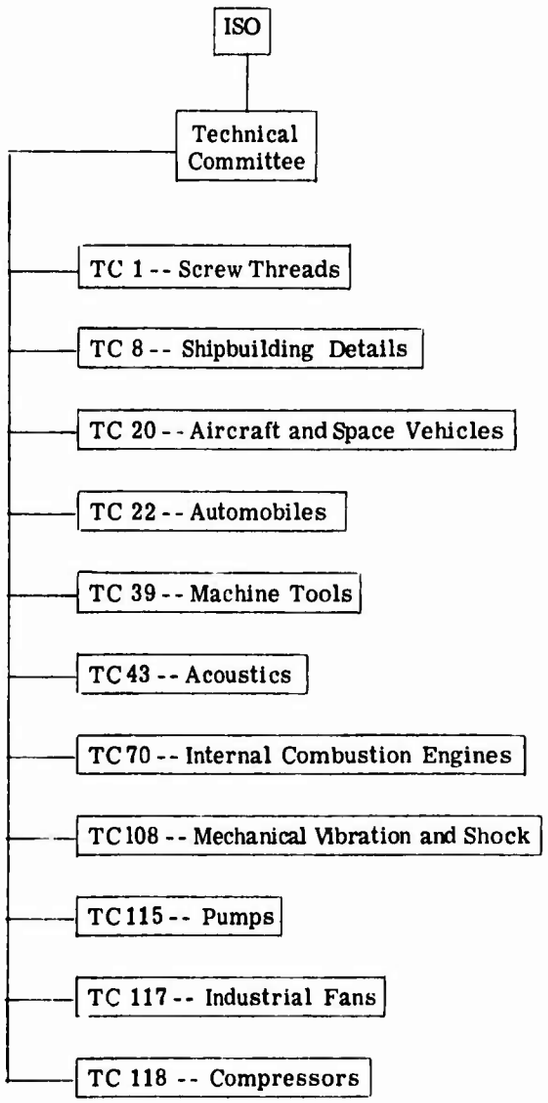

FIG. 2 TOTAL NUMBER COMMITTEES, 148

related to mechanical vibration and shock. Liaison is maintained with TC 43, which is concerned with acoustics and with IEC/TC 29 which deals with electroacoustics. Liaison is also maintained with IEC/TC 50 which deals with environmental testing and particularly with Subcommittee 50A on Shock and Vibration Tests. Within the ISO and IEC, there is continuous concern over possible overlapping in the activities of the various technical committees. Discussions and meetings have been held on several occasions in the past between TC 108 and the IEC technical committees in order to define areas of responsibility, and no problems appear to exist at present.

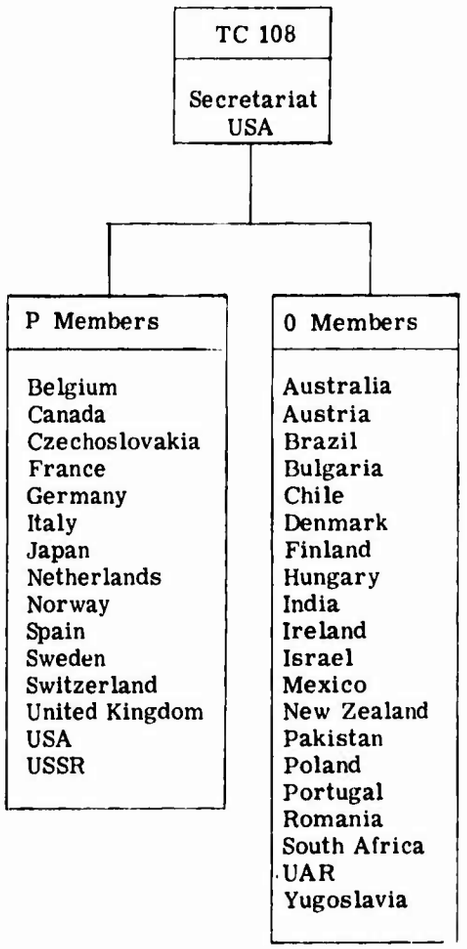

FIG. 3 COUNTRIES INVOLVED IN THE WORK OF TC 108

In order to carry out its work, TC 108 has been divided into various subcommittees and working groups responsible for specific areas of activity. The subcommittees have in turn also been divided into working groups with detailed areas of responsibility. The next six figures show the organization of TC 108 in detail.

In Fig. 5 we can see that the four major subcommittee activities are in the areas of balancing, measurement and evaluation, instrumentation, and human exposure. It should be noted that each one of the subcommittees has a secretariat assigned, thereby assuring that proper coordination is achieved. Two of the subcommittee secretariats are assigned to the United Kingdom and two are assigned to Germany. Initially these activities were carried out by working groups of TC 108. However, during the past few years, their work had become so extensive that it became necessary to reorganize them as subcommittees.

Secretariat: USA (ANSI)

Title: Mechanical Vibration and Shock

Scope: Standardication in the Field of Mechanical Vibration and Shock, including:

1. Terminology;
2. Excitation by sources, such as machines, and vibration and shock testing devices;
3. Elimination, reduction, control, especially by balancing, isolation, damping;
4. Evaluation of acceptable limits for man, and in machines, vehicles and structures;
5. Methods and means of measurement and calibration;
6. Methods of testing.

FIG. 4 SCOPE OF WORK OF TC 108

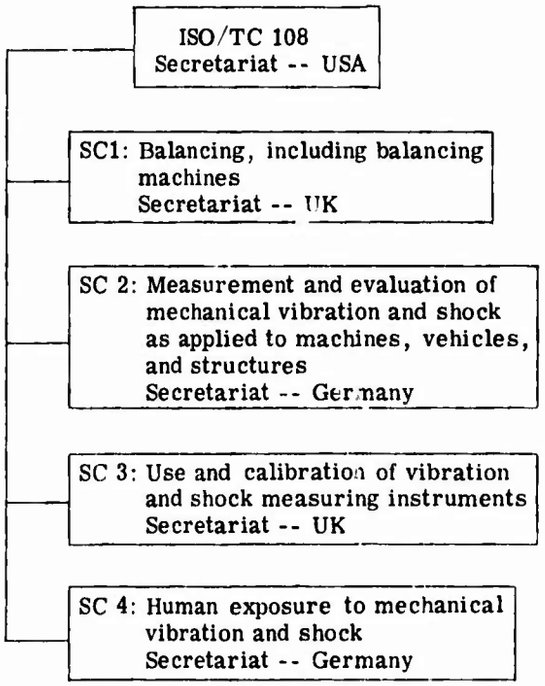

FIG. 5 MAJOR SUBCOMMITTEE ACTIVITIES OF TC 108

In Fig. 6 we can see the detailed areas of involvement of Subcommittee No. 1, which is concerned with balancing. Again, it should be noted that for each working group a country is designated to be responsible for providing a leader to ensure that the work progresses as planned. In connection with WG 1, this group is only responsible for developing the special terminology related to balancing, since, as we will see later, there is a working group directly under TC 108 which has responsibility for terminology generally applicable to mechanical vibration and shock. Also, WG 4 is temporarily inactive due to diminished interest in the past few years.

Figure 7 shows the breakdown into working groups of subcommittee No. 2, which is concerned with measurement and evaluation of mechanical vibration and shock. Separate working groups have been established to cover the areas of machines, ships, and structures, in order to permit preparation of documents which are suitable for the specific applications. The working groups under Subcommittee No. 3 are shown in Fig. 8; WG 1 is not listed since this activity on vibration level meters has been discontinued.

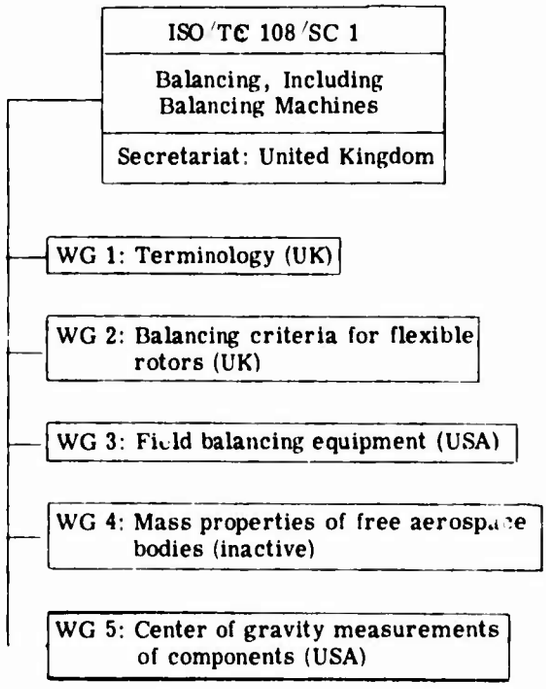

FIG. 6 WORKING GROUPS OF SUBCOMMITTEE NO. 1

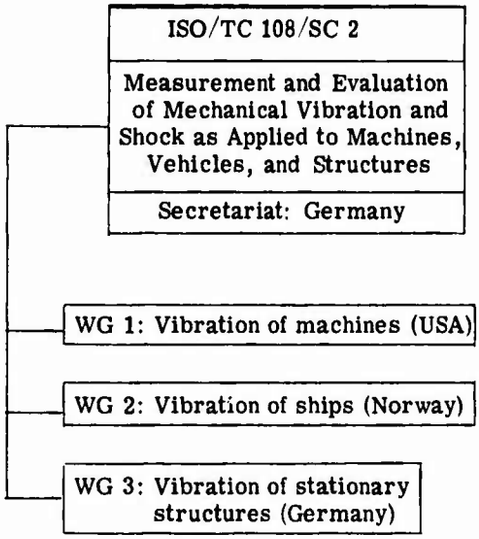

FIG. 7 WORKING GROUPS OF SUBCOMMITTEE NO. 2

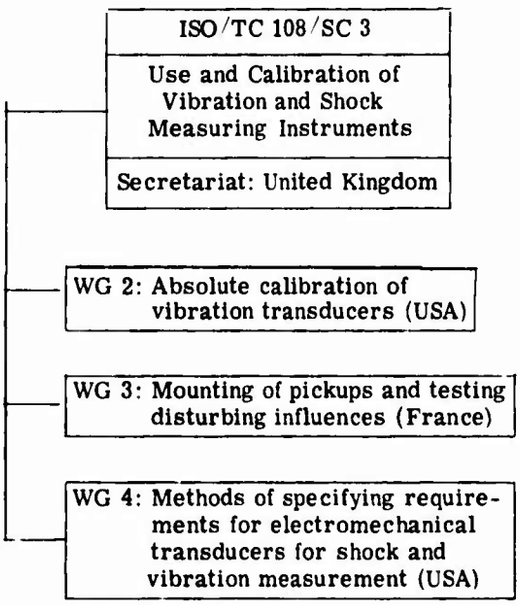

FIG. 8 WORKING GROUPS OF SUBCOMMITTEE NO. 3

In Fig. 9 we see the working groups under Subcommittee No. 4, which is concerned with human exposure to vibration and shock. Reorganization as a subcommittee, rather than a working group, occurred last September. Working Group No. 1 on terminology is again only concerned with special terminology related to human exposure to vibration and shock.

Figure 10 shows the working groups which are organized directly under TC 108. It should be noted that Working Groups Nos. 2, 3, 6 and 7 are not listed. The activities of Subcommittees Nos. 1 to 4 were initially carried out by these working groups, and the latter were disbanded when the subcommittees were established. It is anticipated that in the future some of the current working groups may be reorganized as subcommittees, if their activities should become more extensive. The last two working groups are quite recent, having been officially organized this past September. As indicated earlier, the responsibility for general terminology related to mechanical vibration and shock is dealt with by WG 1.

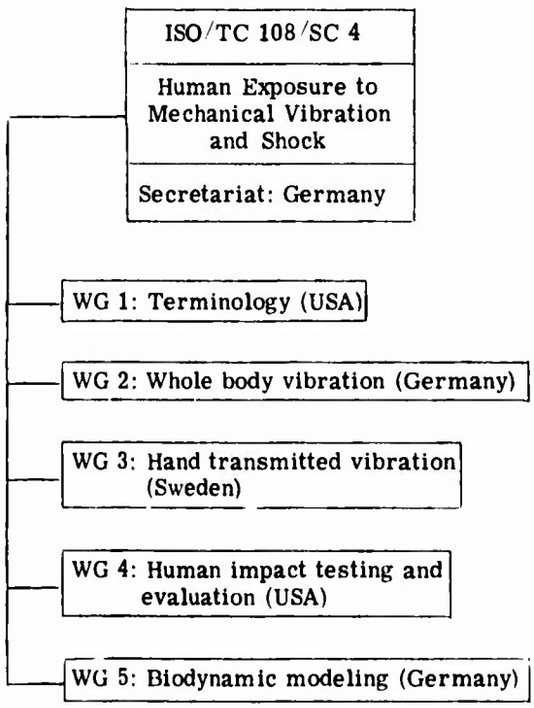

FIG. 9 WORKING GROUPS OF SUBCOMMITTEE NO. 4

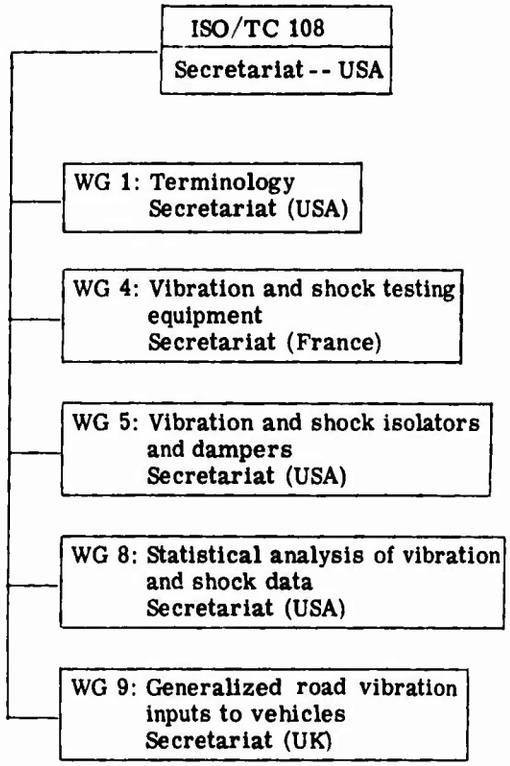

FIG. 10 WORKING GROUPS OF TC 108

What has TC 108 produced since its establishment in 1963? Figure 11 lists first the six documents which have already been approved by the various ISO member bodies and these should become available shortly as international standards. In addition, there are five other documents on which general agreement has been reached, and these should be ready for ISO member body vote shortly. The document on balancing terminology has already been approved, but publication is being delayed so that a vote can be taken incorporating some additional terms.

In addition, work is under way on numerous other documents, as shown in Fig. 12. These items represent areas where preliminary documents have been prepared for consideration by working groups, but where sufficient agreement has not as yet been reached to warrant submission to a vote by the ISO member bodies.

Where does TC 108 expect to go in the future? It is expected that despite the slow pace, each of the documents listed in Figs. 11 and 12 will ultimately be issued as an international standard.

It is also hoped that these standards will be accepted by all ISO member bodies as a basis for their domestic standards. As an example, it is hoped that the fundamental agreements reached internationally by TC 108 will be acceptable to S2, which is responsible for the preparation of USA domestic standards in the field of mechanical vibration and shock.

In reviewing the previous years of activity by TC 108, one cannot overlook that very often initial work indicated wide differences in philosophy and methodology in items under consideration. However, it is encouraging to note that the interchange of ideas by the world experts has been helpful in resolving these differences and has provided the basis for the preparation of documents which could be accepted by the various ISO member bodies.

ISO Standards to Be Issued Shortly

1. Vibration and shock terminology
2. Balance quality of rotating rigid bodies
3. Guide specification for vibration and shock isolators
4. Description and evaluation of field balancing equipment
5. Specifying evaluation standards for mechanical vibration in rotating machines
6. Measurement and evaluation of vibration severity in rotating machines

Documents to Be Voted on Shortly

1. Guide for the evaluation of human exposure to whole body vibration
2. Balancing terminology
3. Mechanical balancing of marine main steam turbine machinery
4. Description and evaluation of the performance of balancing machines
5. Measuring instrument for vibration severity requirements in rotating and reciprocating machines

FIG. 11 STANDARDS TO BE ISSUED AND DOCUMENTS AWAITING VOTING

1. Electrodynamic vibration generator systems

2. Nomenclature for specifying damping properties of materials

3. Guide specification for flexible couplings

4. Balancing criteria for flexible rotors

5. Symbols for front panels of balancing machines

6. Guide for the evaluation of human exposure to hand transmitted vibrations

7. Characterization of shock acceptable to man

8. Method for analysis and presentation of shock and vibration data

9. Classification methods for the evaluation of random vibration

10. Definitions relating to rotating rigid bodies

11. Acceptable limits of vibration in buildings and structures

12. Calibration of shock and vibration pickups.

FIG. 12 DOCUMENTS IN PREPARATION

INTER-NOISE 72

4-6 October 1972
Shoreham Hotel
Washington, D.C.

Inter-Noise 72, the 1972 International Conference on Noise Control Engineering, is sponsored by the Institute of Noise Control Engineering (INCE) in cooperation with the Acoustical Society of America, and the following agencies of the Federal Government: DOL, DOT, EPA, HEW, HUD, and NBS. The purpose of the conference is to provide an opportunity for people who are interested in advancing noise control and noise control engineering to gather together for discussion, consultation, and the exchange of technical information. Another purpose is to provide information and tutorial lectures for persons in industry and government who are just entering the noise field. To this end, the Conference Steering Committee has decided that the Inter-Noise 72 program will be comprised of:

1. Panel Discussions
2. Workshop Sessions
3. Sessions of Technical Papers
4. A Series of Tutorials on Principles of Noise Control
5. An Exhibition of Noise Control

On the first day of the conference, there will be panel sessions in the morning and afternoon addressed to the question, "What constitutes a practical national noise abatement program?" Government officials on the Federal, state, and local levels will participate together with representatives from industry. The sessions will be chaired by L. L. Beranek and W. W. Lang. William M. Magruder, Special Consultant to the President, White House, will be special luncheon guest speaker on this day. Two workshop sessions are planned for the evening of the first day on "Industrial Noise Criteria and Control" and "Noise Legislation and Ordinances."

On the second and third days, there will be three parallel sessions (one tutorial and two technical on recent developments in noise, control engineering). For people who have recently become concerned with noise vibration and shock control a series of tutorials will be presented by first rate speakers who are authorities in the field.

During the conference, an exhibition will be held to feature instrumentation and products and materials which have recently become available for noise and vibration reduction.

A listing of technical sessions of interest follows. Invited papers only are listed. For a detailed program or further general information on INTER-NOISE 72 contact Malcolm J. Crocker, Ray W. Herrick Labs., Purdue Univ., W. Lafayette, Inc. 47907. For information concerning local arrangements, registration, and accommodation contact D. R. Flynn, Natl. Bur. Std., Room A 313, Bldg. 226, Washington, D.C. 20234.

SESSION A — WEDNESDAY 4 OCTOBER

WORKSHOP ON INDUSTRIAL NOISE CRITERIA AND CONTROL

A. L. Cudworth, Chairman
Liberty Mutual Insurance Co.

Hearing Impairment from Noise
Cudworth, A.L. (Liberty Mutual Insurance Co.)

Engineering Control (U.S.A.)
Hill, V.H. (E.I. Dupont)

Engineering Control (Europe)
Taylor, R.M. (Rupert Taylor and Partners Ltd., London, England)

Enforcement of O.S.H.A. Noise Standard
O'Neill, J. (U.S. Dept. Labor)

Hearing Conservation Programs
Imbus, H.R. (Burlington Industries)

SESSION C THURSDAY 5 OCTOBER

WORKSHOP ON COMMUNITY NOISE

C. R. Bragdon, Chairman
Ga. Inst. Tech.

Correlations between Different Community Noise Measures
Bishop, D.E. and Simpson, M.A. (Bolt Beranek and Newman)

Guidelines for the Preparation of a Model Noise Ordinance
Bragdon, C.R. (Ga. Inst. Tech.)

Noise Characteristics of Off-the-Road Construction Vehicles and Equipment
Hart, F.D. and Reiter, W.F.
(N.C. State Univ.)

Control of Construction Noise
O'Neill, J.T. (N.Y. City Transit Authority)

Noise Measurements at Construction Sites
Kessler, F.M. (L.S. Goodfriend and Assoc.)

SESSION E THURSDAY 5 OCTOBER

TECHNICAL SESSION ON MATERIALS FOR NOISE CONTROL
C. H. Allen, Chairman
(Bolt Beranek and Newman)

Application of Materials for Noise Control
Siekman, W. (Riverbank Acous. Lab.)

Five contributed papers.

SESSION F THURSDAY 5 OCTOBER

TECHNICAL SESSION ON MACHINERY NOISE (I)

V. H. Hill, Chairman
(E.I. Dupont)

Control Valve Noise and Its Reduction -- State of the Art
Reethof, G. and Karvelis, A.V. (Pa. State Univ.)

Stationary and Portable Air Compressors
Diehl, G.M. (Ingersol-Rand Co.)

A Review of Noise and Vibration Control for Impact Machines
Bruce, R.D. (Bolt Beranek and Newman)

Noise Control for Industrial Air Moving Devices
Sanders, G.J. (Farr Co.)

Noise of Fans and Blowers
Graham, J.B. (Buffalo Forge Co.)

Noise Control in the Textile Industry
Cudworth, A.L. (Liberty Mutual Insurance Co., and Stahl, J.E. (J.P. Stevens, Inc.)

Practical Design of Machinery Foundations for Vibration and Noise Control
Miller, H.T.; Warnaka, G.E.; and Zalas, J.M. (Lord Corp.)

System Concept to Gear Noise
Pitts, L.S. (Gleason Works)

SESSION G THURSDAY 5 OCTOBER

TECHNICAL SESSION ON SURFACE TRANSPORTATION NOISE
G. J. Thiessen, Chairman
Natl. Res. Council, Ottawa, Ontario, Canada

Prediction of Road Traffic Noise for Environmental Planning
Delaney, M.E. (Natl. Phys. Lab., Teddington, England)

Self-Defense against Surface Transportation Noise
Veneklasen, P.S. (Paul S. Veneklasen and Assoc.)

European Efforts to Reduce the Impact of Traffic Noise
Alexandre, A. (Organization for Economic Cooperation and Development, Paris, France)

Planning for Surface Transportation Noise: A Systems Approach
Beland, R.D. (Wilsey and Ham)

Six contributed papers.

SESSION H FRIDAY 6 OCTOBER

TECHNICAL SESSION ON MACHINERY NOISE (II)

J. Igarashi, Chairman
Univ. Tokyo, Tokyo, Japan

Fourteen contributed papers.

SESSION I FRIDAY 6 OCTOBER

TECHNICAL SESSION ON AIRCRAFT AND AIRPORT NOISE

H. H. Hubbard, Chairman
NASA Langley Res. Ctr.

Design Trends for Noise Control for Aircraft Power Plants
Ciepluch, C.C. (NASA Lewis Res. Ctr.)

Predicting the Reduction in Noise Exposure around Airports
Galloway, W.J. (Bolt Beranek and Newman)

Eight contributed papers.

SESSION J FRIDAY 6 OCTOBER

TECHNICAL SESSION ON NOISE INSTRUMENTATION AND MEASUREMENT

F. Ingerslev, Chairman
Tech. Univ. Denmark, Lyngby, Denmark

The Use of a Reference Sound Source in the Investigation of Industrial Noise Sources
Francis, P. (Electricite de France, Clamart, France)

Sound Power Determination of Machines in Situ
Hubner, G. (Siemens AG, Berlin, Germany)

Measurement Microphones
Rasmussen, G. (Bruel and Kjaer, Naerum, Denmark)

Techniques for Sampling Environmental Noise
Kamperman, G.W. (Kamperman Assoc.)

Some Hearing Damage Risk Criteria and Their Measurement
Boole, R.A. (Gen. Radio Co.)

Seven contributed papers.

SESSION K FRIDAY 6 OCTOBER

TECHNICAL SESSION ON JET NOISE, COMPRESSOR NOISE AND AIRCRAFT NOISE SOURCES

H. S. Ribner, Chairman
Univ. Toronto, Toronto, Canada

Jet Noise Research -- Progress and Prognosis
Siddon, T.E. (Univ. British Columbia, Vancouver, B.C., Canada)

Fan Noise Mechanisms and Control I
Lowson, M.V. (Loughborough Univ. Tech., Loughborough, England)

Fan Noise Mechanisms and Control II
Soffrin, T.G. (Pratt and Whitney Aircraft)

Nine contributed papers.

SEPTEMBER

HUMAN ACOUSTICS
Place: Cleveland, Ohio
Dates: Sept. 11-14
Objective: Understanding and practice will be provided in (a) acoustical measurements, (b) procedures for calibrating hearing aids and air and bone conduction audiometers, and (c) procedures for Walsh-Healy noise exposure measurements.

Contact: Director of Communications, B&K Instruments, Inc., 5111 West 164th St., Cleveland, Ohio 44142

NOISE: DESCRIPTION, ABATEMENT AND EFFECTS ON MAN
Place: Univ. Tenn.
Dates: Sept. 11-15
Objective: The course will begin at a basic level requiring no prior training in acoustics. The fundamentals of acoustic theory, the effects of noise on the ear and body, and noise criteria including the requirements of the Occupational Safety and Health Act will be covered.

Contact: Univ. Tenn., Dept. Conf. Inst., 1345 Circle Park, Knoxville, Tenn. 37916

FINITE ELEMENT ANALYSIS OF PLATES AND SHELLS
Place: Univ. Tenn.
Dates: Sept. 11-15
Objective: Finite element procedures; matrix assembly techniques, equation solving, etc. will be reviewed. This course is intended for graduate engineers and applied mathematicians with some knowledge of plates and shells.

Contact: Univ. Tenn., Dept. Conf. Inst., 1345 Circle Park, Knoxville, Tenn. 37916

SIMILARITY METHODS AND MODELS IN ENGINEERING
Place: Univ. Tenn.
Dates: Sept. 11-15
Objective: The course will show how similarity methods can be used (1) to obtain quantitative data for prototype design with the aid of small models, (2) to obtain experimental data for verification of a theory, (3) to explore fundamental behavior of a little understood analysis, and (4) to evaluate the limitations of an expensive system that might already be in existence.

Contact: Univ. Tenn., Dept. Conf. Inst., 1345 Circle Park, Knoxville, Tenn. 37916

MECHANICAL VIBRATION
Place: Univ. Tenn.
Dates: Sept. 11-15
Objective: Forced and free vibrations of a simple one degree-of-freedom system will be studied. Topics and areas that may be covered can include: vibration analysis of multidegree-of-freedom systems, vibrations of continuous systems, techniques of vibration isolation and reduction, analysis of nonlinear systems and vibrations resulting from shock loads.

Contact: Univ. Tenn., Dept. Conf. Inst., 1345 Circle Park, Knoxville, Tenn. 37916

NOISE IN MANUFACTURING PLANTS
Place: Vancouver, B.C., Canada
Dates: Sept. 6-8
Objective: A simple, informative introduction to acoustics is offered followed by a fairly detailed discussion of a number of representative examples of noise control using basic concepts, straightforward methods, and available materials.

Contact: Miss G. A. Cianci or Mrs. C.S. Kelly, Bolt Beranek and Newman, Inc., 50 Moulton St., Dept. C, Cambridge, Mass. 02138

VIBRATION OF STRUCTURES CURRENT ASPECTS OF DAMPING AND CONTROL
Place: Pa. State Univ.
Dates: Sept. 17-22
Objective: This seminar is for the benefit of engineers and scientists working in industry and government. It will provide the participant with a fully up-to-date account of results and techniques for understanding and controlling structural vibration. The basic principles and methods of vibration control will be emphasized. The participant should become able to apply new knowledge to his immediate problems, to organize better his approach to other problems of the present day, and, through increased understanding of the field and familiarity with the relevant literature, to be better equipped to tackle the problems of the future.

Contact: Pa. State Univ., Conf. Ctr. -- Continuing Ed. 410 J. Orvis Keller Bldg., Univ. Park, Pa. 16802

DOCUMENT INFORMATION

Copies of articles abstracted are not available from the Shock and Vibration Information Center (except for those generated by SVIC). Inquiries should be directed to library resources, authors, or the original publishers. According to prefixed letters on document numbers, articles can be obtained from the following agencies:

AD, N } Defense Documentation Center, Document Library, Cameron Station, Alexandria, Va. 22314

ASME - American Society of Mechanical Engineers, 345 E. 47th St., New York, N.Y. 10017

NASA - National Aeronautics and Space Administration, Scientific and Technical Information Division, Washington, D.C. 20546

NSA - Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (or NTIS)

PB - National Technical Information Service, Dept. Commerce, Springfield, Va. 22151

SAE - Society of Automotive Engineers, 2 Pennsylvania Plaza, New York, N.Y. 10001

Patent descriptions should be requested from the U.S. Patent Office, Washington, D.C. 20231. Doctoral theses are available from University Microfilms (UM), 313 No. Fir St., Ann Arbor, Mich.

Addresses following the authors' names in the abstracts refer only to the first author listed.

ANALYSIS AND DESIGN

ANALOGS AND ANALOG COMPUTATIONS

(Also see No. 1306)

72-1200

THE PROGRAMMING OF HARMONIC OSCILLATIONS WITH VARIABLE FREQUENCY. RESONANCE INVESTIGATIONS ON ANALOG COMPUTERS

Kühlborn, H.
(Institut fuer Betriebstechnik der Forschungsanstalt für Landwirtschaft, Braunschweig-Völkenrode, Germany)

VDI Z 114(4), 248-252 (Mar. 1972) 4 refs

Key Words: analog simulation techniques, harmonic response, oscillation

Research and development tasks frequently lead to such extensive and nonlinear mathematics problems that electronic computing machines are required for their solution Thereby, analog computers did not achieve the significance of digital computers. Analog computers, however, are particularly well suited for the simulation of processes which can be described by differential equations and, therefore, are well suited for the treatment of oscillation problems. The methods used for the solution of such problems are also influenced by the type of computation elements available. Novel computation elements allow for the application of a modified method for the investigation of oscillation processes though, in principle, this method is already known. (In German)

ANALYTICAL METHODS

(Also see Nos. 1210, 1222, 1284, 1295, 1332)

72-1201

A STUDY OF HALF-SUBHARMONIC OSCILLATIONS BY THE METHOD OF HARMONIC BALANCE

Ashwell, D.G. and Chauhan, A.P.
(Civil and Struc. Engr. Dept., Univ. Col., Cardiff, Wales)

Symp. on Nonlinear Dynamics held at Loughborough Univ. Tech., England, (Mar. 27-28, 1972) 16 pp, 4 refs

Key Words: harmonic analysis

The method of harmonic balance is applied to a study of the half-subharmonic oscillations observed with single degree of freedom systems having nonlinear spring characteristics of skew-symmetrical form. An investigation of the accuracy of the method concludes that it can be applied in those cases which lead to such subharmonic behavior in practice. The paper is written from the standpoint of the structural engineer so that excitation caused by support movement or by force applied to the mass, is considered, and the results are presented as response curves relating subharmonic behavior to excitation frequency for constant amplitudes of excitation.

72-1202

MODAL ANALYSIS OF RANDOM STRUCTURAL SYSTEMS

Hasselman, T.K. and Hart, G.C. (TRW Systems, Redondo Beach, Calif.)

ASCE J. Engr. Mech. Div. 98(3), 561-579 (June 1972) 16 refs

Key Words: component mode synthesis, modal analysis

A method for computing the variance of structural dynamic mode properties using component mode synthesis is presented. The method is entirely compatible with Hurty's formulation of component mode synthesis for redundant structures. The computation of eigenvalue and eigenvector derivatives with respect to random structural parameters is executed in an efficient

manner. Numerical results indicate that reasonably accurate results may be achieved for the lower modes even when a relatively small percentage of available component modes is used. Specific requirements depend on the distribution of randomness throughout the structure and obviously on the spacial correlation of the randomness. As the randomness becomes less uniform and correlation intervals over the structure become smaller, more component modes will be required in the synthesis to achieve the necessary degree of resolution. In extreme cases it may turn out that the number of component modes required to make the variances converge is much larger than the number required for convergence of the means. In such cases the final eigenvalue problem could become unacceptably large. There is an alternative, however, which allows the size of the final eigenvalue problem to be governed by convergence requirements on mean eigenvalues and eigenvectors only.

72-1203

THE RESPONSE OF SYSTEMS WITH A SMALL STOCHASTIC PARAMETER
Penrod, D.D.
Iowa Univ., Dept. of Mech. and Hydraul., Iowa City, Ia., Rept. No. THEMIS-UI-28, (Feb. 1971) 12 pp

Key Words: forced vibration, stochastic processes, strings

Two problems in the area of stochastic systems are discussed: (1) the eigenvalue problem which is solved using some techniques of functional analysis; and (2) extended techniques are applied to the problem of forced vibration of a system which has a small stochastic parameter. As an example, the techniques are applied to a string of random density.
AD-737750

72-1204

VISUALIZING AND CALCULATING THE RESPONSE DUE TO A PRESSURE IMPULSE OVER AN ARBITRARY SURFACE
Schomer, P.D. (Univ. Ill., Urbana, Ill.)
J. Acoust. Soc. Amer. 51 (5), 1670-1674 (May 1972) 2 refs

Key Words: shock response

Most radiation problems are normally solved in the frequency domain, and quite often transform techniques are employed. This paper points to a large class of problems for which the solutions are much more readily found directly in the time domain. In many cases these solutions are expressible in terms of elementary generalized functions and hence are easily transformed, so the steady state frequency domain solutions follow immediately. More specifically, a simple method is presented to visualize and calculate the response at any point P in space to a pressure impulse occurring at time t_0 in an area of space defined by an arbitrary hypothetical surface or curve.

72-1205

ON THE RESPONSE OF LINEAR SYSTEMS TO MODULATED SINUSOIDAL INPUTS
Stevens, K.K. (Ohio State Univ., Columbus, Ohio)
J. Sound and Vib. 21 (3), 295-306 (Apr. 8, 1972) 3 refs

Key Words: linear systems, periodic response, series solution

An approximate series solution for the steady state response of linear time-invariant systems to sinusoidal inputs with slowly varying amplitude and/or phase is presented. The solution is expressed in terms of the modulation function and its time derivatives, and the system transfer function and its derivatives, with respect to frequency. The first two or three terms in the series give a very good approximation to the response, with the possible exception of the case of very lightly damped systems with exciting frequency near a resonant frequency. The accuracy of the solution is demonstrated by applying it to an example problem for which an exact solution also can be obtained. The approximate results are also compared with those obtained by an asymptotic method. The approximate method of solution presented has certain advantages over other methods of exact or approximate solution. These advantages are discussed. The method is particularly convenient for use in viscoelastic vibration problems.

72-1206

BOUNDS ON FIELD QUANTITIES IN NATURAL VIBRATION PROBLEMS IN ELASTO-MECHANICS
Stumpf, H.
Acta Mech. 13 (3-4), 225-243 (1972) 13 refs

Key Words: eigenvalue problems, natural frequencies

Possibilities are investigated for bounding field quantities of an eigenstate. It is assumed that upper and lower bounds for the eigenvalues are known and that the energy of the corresponding Green's state is finite. Bounds are given for the first eigenfunction for a plate problem. (In German)

IMPEDANCE METHODS

72-1207

DYNAMIC FORCE AND TORQUE ANALYSIS OF MECHANISMS USING DUAL VECTORS AND 3 x 3 SCREW MATRIX

Bagci, C. (Tenn. Tech. Univ., Cookeville, Tenn.)

J. Engr. Indus., Trans. ASME 94(2), 738-745 (May 1972) 7 refs

Key Words: mechanisms

The method of determining dynamic force and torque distributions in mechanisms by using dual vectors and a 3 x 3 screw matrix is presented. The dual equilibrium equations for each moving link of a mechanism are written as a null resultant dual force vector in a reference system located on the link. The resulting 6 x (n – 1) equilibrium equations for an n-link mechanism are solved for the unknown force and torque components at the pair locations, and for the input force or torque required to drive the mechanism to produce the specified dual output force. The dynamics of the mechanism is governed by introducing the dual inertia force acting on a link, which is determined as the negative of the time rate of change in the dual momentum of the link resulting from its own mass and mass moments of inertia, in the dual equilibrium equation for that link. Dynamic analyses of the 4R plane and the RCCC space mechanisms are performed. Dynamic transmissivities are defined. The RCCC mechanism is analyzed in a numerical example and the results of the dynamic distributions are compared with those of static distributions.

INTEGRAL TRANSFORMS

72-1208

VIBRATIONS OF NONLINEAR SYSTEMS, THE METHOD OF INTEGRAL EQUATIONS

Rozenvasser, E.N.

Transl. of mono. Kolebaniya Nelineinyk. Syst. Metod Integralnikh Uravnenii (Aug. 1971) 502 pp

Key Words: nonlinear systems, vibration response

Several applied problems in the theory of nonlinear oscillations are systematically examined using the method of integral equations. An intimate relationship is established between small parameter classical methods and the methods of investigating nonlinear systems of automatic control based on the so-called filter hypothesis. Results thus obtained are applicable to a broad class of systems described by nonlinear operator equations. Certain problems of periodic oscillations unrelated to the use of integral equations are also considered.
AD-738124

NONLINEAR ANALYSIS

(Also see Nos. 1208, 1301, 1321, 1322, 1334)

72-1209

NATURAL MODES OF A COUPLED NONLINEAR SYSTEM

Anand, G.V. (Indian Inst. Sci., Bangalore, India)

Intl. J. Nonlinear Mech. 7(1), 81-92 (Feb. 1972) 3 refs

Key Words: coupled systems, mass-spring systems, natural frequencies

The natural modes of a nonlinear system with two degrees of freedom are investigated. The system, which may contain either hard or soft springs, is shown to possess three modes of vibration, one of which does not have any counterpart in the linear theory. The stability analysis indicates the existence of seven different modal stability patterns depending on the values of two parameters of nonlinearity.

72-1210

THE TRANSIENT SOLUTION OF A STRONGLY NONLINEAR, SECOND-ORDER, DIFFERENTIAL EQUATION IN TERMS OF JACOBIAN ELLIPTIC FUNCTIONS

Christopher, P.A.T. (Cranfield Inst. Tech.)

Symp. on Nonlinear Dynamics held at Loughborough Univ. Tech., England (Mar. 27-28, 1972) 31 pp, 17 refs

Key Words: elliptic functions, nonlinear systems

A more manageable approximate solution is developed for the equation,

$$x'' + bx' + c_1 x + c_3 x^3 = 0, \quad (b, c_1 \text{ and } c_3 > 0).$$

The new equation takes the form,

$$x = C(t)e^{-\frac{1}{2}bt}\, Cn\,[\,\cdot(t),\ \cdot(t)]$$

and expressions are developed for C(t), .(t) and .(t). On the basis of a numerical comparison with an exact solution, this approximation appears to be of high accuracy, however, more extensive numerical comparisons are required.

72-1211

PERIODIC SOLUTIONS OF A FORCED SYSTEM WITH HYSTERESIS
Drew, J.H. (Col. William and Mary, Williamsburg, Virginia)
Intl. J. Nonlinear Mech. 7(1), 93-99 (Feb. 1972) 6 refs

Key Words: hysteretic damping, periodic response

A phenomenon displayed by many physical systems, hysteresis has received much attention in its bilinear and slightly nonlinear forms. Allowing a more general type of hysteresis, this paper examines the existence of certain periodic motions of a system with small forcing which are near the largest periodic motion of the corresponding unforced system.

72-1212

INVESTIGATION OF PHASE SYNCHRONIZATION AND FLOW OF ENERGY IN SUBHARMONIC VIBRATION
Meinke, P.H. (D-8061 Grosinzemoos, Sandstr. 9, Deutschland)
Ing. Arch. 41(3), 194-212 (1972) 12 refs

Key Words: subharmonic oscillations

Transient states of subharmonic oscillations, which are known to appear as disturbances in the stages of electrical frequency multipliers, are studied by means of a mechanical model oscillator. Experimental results lead to a treatment of the effects as double-frequency processes with an additional rectifying property. Special attention is then focussed on the energy flow through the nonlinear element assuming at first constant excitation and finally phase modulated excitation. (In German)

72-1213

NONLINEAR VIBRATION OF BUCKLED BEAMS
Min, G.B. and Eisley, J.G. (Bendix Corp., Ann Arbor, Mich.)
J. Engr. Indus., Trans. ASME 94(2), 637-646 (May 1972) 11 refs

Key Words: buckled beams, forced vibration, free vibration, periodic response

The steady state response and stability of free and forced vibration of simply supported, axially restrained, buckled beams is investigated. The equations of motion dealing with the buckled state include the effect of an initial displacement either by initial load or by initial temperature. By an assumed mode solution, the response and stability of two types of vibration are determined: snap-through (symmetrical) and one-sided (unsymmetric) vibration. The theoretical results of the response and stability are verified by analog computer simulation. It is concluded that the stability of the unsymmetric vibration is not a problem and that the different orders of parametric response of the rest modes (the modes originally not excited) in symmetric vibration correspond to the instability regions determined for the approximate single mode response.

72-1214

AN EXTENSION OF BEECHAM'S METHOD TO NONLINEAR SYSTEMS HAVING n DEGREES OF FREEDOM
Simpson, A. (Univ. Bristol)
Symp. on Nonlinear Dynamics held at Loughborough Univ. Tech., England (Mar. 27-28, 1972) 18 pp, 7 refs

Key Words: nonlinear analysis

Recent experience indicates that a development by L. J. Beecham of the simple Kryloff and Bogoliuboff first approximation method for single freedom systems is capable of producing good results in strongly nonlinear situations. Whether this development can be extended to the n degree-of-freedom case with equal success is explored. This is achieved by the use of averaged kinetic energy and virtual work terms in Lagrange's equation. The method is illustrated in application to the study of damped oscillations of a two degree-of-freedom system with cubic stiffness nonlinearity.

OPTIMIZATION TECHNIQUES

(Also see Nos. 1332, 1362)

72-1215

MULTIPARAMETER IDENTIFICATION AND OPTIMIZATION METHODS FOR LINEAR CONTINUOUS VIBRATORY SYSTEMS
Dale, O.B.
Purdue Univ., PhD Thesis (1970) 206 pp

Key Words: linear systems, optimization, parameter identification

The multiparameter identification of linear continuous vibratory systems using resonant frequency and frequency response data is discussed. The systems and boundary conditions considered are assumed to be known up to a set of unknown constant parameters which are identified using the experimental data. These identification methods are extended to multiparameter optimization problems for which the unknown

parameters are determined to yield an optimum performance index in frequency response space. The thesis is divided into three main areas of investigation: the identification of conservative or near conservative systems, the identification of nonconservative systems, and the extension of these identification methods to the multiparameter optimization of systems.
U.M. 72-12793

PERTUBATION METHODS

72-12[illegible]6

A P[illegible]RBATION PROCEDURE FOR WE[illegible]Y COUPLED OSCILLATORS
Kabakow, H. (Univ. Calif., Los Angeles, Calif.)
Intl. J. Nonlinear Mech. 7(1), 125-137 (Feb. 1972) 5 refs

Key Words: oscillators, perturbation method

Problems involving systems of oscillators with weak nonlinear (polynomial) coupling are of interest in connection with the ergodic problem of statistical mechanics and as simple models of nonlinear interactions. These systems have been studied by Ford and Waters (1) and Jackson (2, 3), who used variations of the Wigner-Brillouin (WB) procedure to calculate the dynamics. The principal difficulty with WB is that it places too strong a restriction on the analytic form the answer can take. With this restriction, the famous "small divisor" problem can emerge at some point in the calculation. This paper describes the "N-timing" procedure (of which WB is essentially a special case), shows how it can be applied to calculate the long-time dynamics of coupled oscillator systems, and establishes by computer experiments the accuracy of N-timing for a particular example.

STABILITY ANALYSIS

(Also see Nos. 1283, 1290, 1366)

72-1217

STABILITY OF THE INVERTED PENDULUM SUBJECTED TO ALMOST PERIODIC AND STOCHASTIC BASE MOTION -- AN APPLICATION OF THE METHOD OF AVERAGING
Mitchell, R. (Purdue Univ., Lafayette, Ind.)
Intl. J. Nonlinear Mech. 7(1), 101-123 (Feb. 1972) 21 refs

Key Words: pendulum, stability

The stability of the inverted pendulum is reexamined using the method of averaging. The stability boundaries are determined for small amplitude, high frequency, sinusoidal and almost periodic base motions. It is shown that the solutions on the stability boundaries can be approximated by specific Mathieu functions for an almost periodic base motion. The method of averaging leads to the discovery by analog computer simulation that the pendulum can be stabilized in the inverted position with a base motion that is a simple function from a stochastic process with a continuous power spectral density function.

72-1218

STABILITY ANALYSIS IN STRUCTURAL DYNAMICS USING LYAPUNOV FUNCTIONALS
Parks, P.C. and Pritchard, A.J. (Univ. Warwick, Coventry, England)
Symp. on Nonlinear Dynamics held at Loughborough Univ. Tech., England (Mar. 27-28, 1972) 11 pp, 9 refs

Key Words: Lyapunov method, stability

The second method of Lyapunov, which has been applied successfully to many problems described by ordinary differential equations, has recently been extended to a number of problems described by partial differential equations, including some well known problems in the structural dynamics field. The natural language for this generalization of the Lyapunov technique is that of functional analysis and the first part of the paper describes briefly some of the relevant concepts -- inner products, norms, completeness, Hilbert space, semigroup operators, Lyapunov stability and Lyapunov functionals. A general method of constructing Lyapunov functionals, the P method, is described and the Lyapunov functional analysis is applied to a number of problems including the wave equation with nonlinear damping, the stability of the Euler strut including a "follower-force" case, divergence of an aircraft wing including a nonuniform case, panel flutter and feedback control of a flexible missile.

STATISTICAL METHODS

72-1219

LINEAR RESPONSE TO NONSTATIONARY RANDOM EXCITATION
Hasselman, T.K. (TRW Systems, Redondo Beach, Calif.)
ASCE J. Engr. Mech. Div. 98(3) 519-530 (June 1972) 14 refs

Key Words: linear oscillation, multidegree-of-freedom systems, random excitation

A method for computing the mean-square response of linear systems to nonstationary random excitation is presented. The method is suitable for application to multidegree-of-freedom systems when the mean square response at a point caused by excitation applied at another point is desired. Both the stationary process and the modulating function may be arbitrary. The method utilizes a fundamental component of transient response to synthesize the total response. The role played by this component is analogous to that played by the Green's function or impulse response function in the convolution integral. Once this solution has been determined either numerically or in closed form) for a given problem, the mean square response for an arbitrary modulating function can readily be computed. The function can thus be changed without having to recompute that part of the solution which does not depend on it. The method is applied to a single degree-of-freedom problem excited by nonstationary correlated noise.

VARIATIONAL METHODS

72-1220

ENFRGY METHODS IN PLATE VIBRATION ANALYSIS
Sakaguchi, R.L.
Univ. Toronto, PhD Thesis (1970)

Key Words: energy methods, mode shapes, natural frequencies, plates, variational methods

A variational principle, complementary to Hamilton's principle, is applied to the vibration analysis of elastic plates. The functional of the principle involves force-type variables describing the equilibrium states of an elastic body. This thesis is primarily concerned with the developing methods for calculating plate natural frequencies and modes of vibration based on related variational principles.
Natl. Library of Canada, Ottawa, Canada (microfilm)

FINITE ELEMENT MODELING

72-1221

DYNAMIC ANALYSIS OF SANDWICH BEAMS
Ahmed, K.M. (Inst. Sound and Vib. Res., Univ. Southampton, Southampton SO9 5NH, England)
J. Sound and Vib. 21(3), 263-276 (Apr. 8, 1972) 21 refs

Key Words: finite element technique, sandwich beams, transverse shear deformation

A finite element analysis technique which includes the effect of transverse shear deformation for honeycomb sandwich beams is described. The discrete element employed has six degrees of freedom per node corresponding to u, $\partial u/\partial y$, φ, $\partial\varphi/\partial y$, w and $\partial w/\partial y$. All three rigid body modes for the element are adequately represented by this model. The generalized stiffness and mass matrixes for this relatively simple element are presented. The analysis is general in the sense that flexural modes, in-plane and shearing motion can be readily obtained.

72-1222

FREE VIBRATION OF THICK, LAYERED RECTANGULAR PLATES BY A FINITE LAYER METHOD
Cheung, Y.K. and Chakrabarti, S. (Univ. Calgary, Calgary, Alberta, Canada)
J. Sound and Vib. 21(3), 277-284 (Apr. 8, 1972) 13 refs

Key Words: finite element technique, free vibration, laminates, rectangular plates

A three-dimensional linear, small deformation solution for the free vibration of thick, layered rectangular plates with various boundary conditions is developed using a finite layer method which is an extension of the well-known finite element method. In this method, the plate is divided into a number of layers, and the stiffness matrix of a layer element is obtained by assuming the displacement functions, u, v and w to by of the form X(x) Y(y) Z(z), in which X(x) and Y(y) are suitable beam function series satisfying the appropriate boundary conditions of the plate, and Z(z) is a simple linear polynomial. A consistent mass matrix is also formed for each layer. The stiffness and mass matrixes of all the layers forming a plate are then assembled to give an eigenvalue matrix which can be solved for the frequencies and the mode shapes on an intermediate size computer. The method is simple but versatile, and complex problems involving anisotropic materials or thick layered construction can all be handled easily.

MODELING

(Also see Nos. 1212, 1222, 1258, 1287, 1295, 1298, 1310, 1317, 1391, 1397, 1404)

72-1223

A NONLINEAR DYNAMIC LUMPED PARAMETER MODEL OF A RECTANGULAR PLATE

Bayles, D.J.; Lowery, R.L.; and Boyd, D.E. (Sch. Mech. and Aerosp. Engr., Okla. State Univ., Stillwater, Okla.)

J. Sound and Vib. 21(3), 329-337 (Apr. 8, 1972) 6 refs

Key Words: lumped parameter method, mass-spring systems, mathematical models, rectangular plates

A lumped parameter model of a rectangular plate is developed by assuming fundamental mode solutions and using Hamilton's Principle and the Euler equations to set up the differential equation of motion for the system. The plate theory used may be described as the dynamic analog of the Von Karman large-deflection theory. Four sets of symmetrical boundary conditions are considered with the restriction of uniform pressure dynamic loads. The model takes the form of a mass on a cubic-hardening spring with each term defined by algebraic expressions of the plate parameters. The results for some specific problems are compared with two previous solutions. This method is less accurate but simpler to develop and apply than the compared solutions.

72-1224

THE RESPONSE OF AN INTAKE TOWER AT HOOVER DAM TO EARTHQUAKES

Cozart, C.W.

Bur. Reclamation, Engr. and Res. Ctr., Denver, Colo. REC-ERC-71-50 (Dec. 1971) 25 pp

Key Words: dams, seismic response

Records of earthquakes from strong-motion seismographs at Hoover Dam made possible the comparison of time dependent accelerations measured near the top of one of the intake towers with accelerations computed by a lumped mass, generalized coordinate method. Output is the acceleration vs time graph of the top lumped mass of the tower. Graphs for three earthquakes and for two values of damping are included.

PB 207449

72-1225

A NEW MODEL FOR THE DYNAMIC BEHAVIOR OF ELASTOMERIC MATERIALS

Edwards, J.L. and Hicks, D.R.

Air Force Materials Lab., Wright-Patterson AFB, Ohio, AFML-TR-71-272 (Dec. 1971) 47 pp

Key Words: dynamic response, elastomers, mathematical model, rubber

A mathematical model describing the dynamic behavior of rubber or elastomeric materials is described. It is based on Flory's concept of the rotational isomeric state model of polymer chains. With a unit step strain applied to the material, each polymer chain is assumed to go from an unrelaxed initial configuration to a fully relaxed equilibrium state at a rate described by a nonlinear first-order differential equation. The differential equation is derived by assuming that the relaxation rate is proportional to a probability function, namely, the probability that the elastic and thermal energy present in the chain is greater than or equal to a critical value.

AD-739857

COMPUTER PROGRAMS

(Also see Nos. 1227, 1304)

72-1226

METHODS FOR COMPUTING FLUID LOADING AND THE VIBRATORY RESPONSE OF FLUID-LOADED FINITE RECTANGULAR PLATES SUBJECT TO TURBULENCE EXCITATION -- OPTION 3

Leibowitz, R.C.

Naval Ship Res. and Dev. Ctr., Bethesda, Md. NSRDC-2976C (Sept. 1971) 187 pp

Key Words: computer programs, rectangular plates, ship structures, turbulence excitation, vibratory response

Various methods are presented for computing heavy or light fluid loading or thin finite rectangular plates. Preferred methods or computation are recommended. These methods and a corresponding computer program are of particular value in extending previously formulated digital computer programs for obtaining the vibroacoustic response to turbulence excitation of a plate. Computer results are given for a particular case involving the effect of fluid loading on the vibratory response of a plate subject to turbulence excitation.

AD-737203

DIGITAL SIMULATION
(Also see No. 1374)

72-1227
SIMULATION OF THE DYNAMICS OF MACHINERY
Dix, R.C. and Lehman, T.J. (Ill. Inst. Tech., Chicago, Ill.)
J. Engr. Indus., Trans. ASME 94(2), 433-438 (May 1972) 6 refs

Key Words: linkages, mathematical models, mechanical elements, MEDUSA (computer program), springs

The dynamics of motion of general, two-dimensional machine systems incorporating linkage elements is studied by a procedure which eliminates equation writing. The method is similar to chemical engineering process analysis procedures utilizing an interconnection matrix to describe attachments between components of a system. A digital computer program based on the procedure, the Machine Dynamics-Universal System Analyzer (MEDUSA), is written and tested. This program contains subroutines for simulating the behavior of the following standard components: rigid links, torsional and linear springs, torsional and linear dashpots, force sources, motion generators, and flexible beams. Gears, chain drives, hydraulic transmissions, electric motors, and other components may be added to the simulation without difficulty.

72-1228
A DYNAMIC SIMULATION OF PASSENGER RAILROAD CARS WITH EXPERIMENTAL COMPARISON
Strong, P.M. (The Budd Co., Fort Washington, Pa.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-337, 13 pp

Key Words: high-speed transportation systems, simulation, test models

The dynamic simulation of a single car described in this paper is found to be applicable to 40-ft long rapid transit cars and 80-ft long intercity cars. Experimental evidence which guided the work is described. Avenues for continuing work to improve the relation between models and reality are identified. Emphasis is on simulation of a Metroliner car which was validated with a road test. Parameters are identified by laboratory testing of a full-size car.

PARAMETER IDENTIFICATION
(Also see No. 1215)

DESIGN TECHNIQUES
(Also see No. 1294)

STANDARDS AND SPECIFICATIONS

72-1229
FEDERAL REGULATION OF OCCUPATIONAL NOISE EXPOSURE
Van Atta, F.A. (Occupational Safety and Health Admin., U.S. Dept. of Labor, Washington, D.C.)
S/V Sound and Vib. 6(5), 28-31 (May 1972)

Key Words: industry, noise tolerance, standards and codes

The objectives of the U.S. Department of Labor in controlling occupational noise exposures are explained. They are to prevent hearing impairment resulting from occupational noise exposure in a large percentage of the working population. These goals are being approached through measurement of environmental noise, noise reduction where necessary or ear protection as a final resort. Periodic hearing tests are recommended to check on the efficiency of these control measures.

72-1230
LAWS AND REGULATORY SCHEMES FOR NOISE ABATEMENT
George Washington Univ., Spons. by U.S. Environ. Protection Agcy., Office of Noise Abatement and Control, Washington, D.C., NTID300.4 (Dec. 1971)
327 pp, 127 refs

Key Words: noise abatement, standards and codes

Regulatory schemes for environmental noise abatement are surveyed. Abatement functions are distributed among federal state, and local governmental levels and are largely uncoordinated. Schemes are directed to abatement at the source, reduction of the effects of noise, and to remedies (by private action) to abate the source or to reduce the effects. Most noise abatement regulation has taken place at the local level. Continuing problems in the regulation of environmental noise are identified.

72-1231
FUNDAMENTALS OF NOISE: MEASUREMENT, RATING SCHEMES, AND STANDARDS
Natl. Bur. Standards, Spons. by U.S. Environ. Protection Agcy., Office of Noise Abatement and Control, Washington, D.C.,
NTID300.15 (Dec. 1971) 163 pp, 23 refs

Key Words: noise measurement

An introduction to noise, including the interrelationship between physical measures and phychological responses is offered. The basic principles of sound generation and propagation are discussed and the measurement of both the physical attributes of noise and the effects of noise on people. The suitability and effectiveness of various noise exposure rating schemes, used to estimate or predict the effects of noise on man, are discussed and critiqued. Included are sample calculations of sound level, loudness level, and perceived noise level for five selected spectra. The need for inclusion of well-defined environmental and operational requirements into measurement procedures is stressed for those devices where the noise produced is dependent on the surroundings and the operation of the device. A glossary of pertinent acoustic terminology and a compilation of existing standards related to noise, including a brief description of the intent and scope of each, are presented.

SURVEYS
(Also see No. 1246)

72-1232
A SURVEY OF OPTIMIZATION OF MECHANICAL DESIGN
Seireg, A. (Univ. Wis., Madison, Wis.)
J. Engr. Indus., Trans. ASME 94(2), 495-499 (May 1972) 102 refs

Key Words: dynamic systems, mechanical elements, optimization, rotating structures

Some examples of the use of optimization techniques in the design of mechanical elements and systems are reviewed. The cases cited include gears, bearings, dynamic systems, rotating disks, pressure vessels, shafts under bending and torsion, beams subjected to longitudinal impact, and problems of elastic contact and load distribution.

---

72 1233
THE ECONOMIC IMPACT OF NOISE
Natl. Bur. Standards, Sponsored by U.S. Environ. Protection Agcy., Office of Noise Abatement and Control, Washington, D.C.,
NTID300.14 (Dec. 1971) 104 pp, 64 refs

Key Words: aircraft noise, human factors engineering, noise, noise reduction, traffic noise

The economic impact of noise and noise abatement in the residential and industrial environments is viewed. Estimated rates of growth of selected noise generators, both external to the home and those used within the home, are reviewed. Noise sources that create the most annoyance in the residential environment, namely, aircraft and motor vehicles, are examined. In the case of aircraft noise, an attempt is made to estimate the aggregate cost of noise and also the cost of abatement from several different approaches. Some of the benefits to be derive' from the abatement of aircraft noise are also considered.

TUTORIAL
(Also see Nos. 1231, 1263)

72-1234
MECHANICAL VIBRATION
Davis, H.H. (Univ. Adelaide, Adelaide, So. Australia)
J. Inst. Engr. Aust. 44(1-2), 11-14 (Jan./Feb. 1972) 3 refs

Key Words: vibration response

This article is the first of a series of introductory articles for the nonspecialist aimed at elucidating the extent to which the widespread environmental problem of mechanical vibration can presently be controlled.

72-1235
VIBRATION MEASUREMENT
Macinante, J.A. (Natl. Standards Lab., Sydney, Australia)
J. Inst. Engr. Aust. 44(3), 6-8 (Mar. 1972) 2 refs

Key Words: vibration control, vibration measurement

The second of a series of introductory articles on vibration control is presented.

ENVIRONMENTS

ACOUSTIC

(Also see Nos. 1229, 1230, 1275, 1307, 1315, 1316, 1319, 1328, 1339, 1351, 1369, 1373, 1394)

72-1236

THEORY AND MEASUREMENT OF MODAL SPECTRA IN HARD-WALLED CYLINDRICAL DUCTS

Bolleter, U. and Crocker, M.J. (Herrick Labs., Sch. Mech. Engr., Purdue Univ., Lafayette, Ind.)

J. Acoust. Soc. Amer. 51(5), 1439-1447 (May 1972) 26 refs

Key Words: ducts, fans, noise measurement

The propagation and interaction of acoustic modes in ducts is of importance for the measurement and control of sound generated by ducted fans and compressors. A method is presented by which the modal spectra (pressure and power spectral densities) for the first nine cross modes can be determined from pressure cross-spectrum measurements in the duct. The flow noise, a potential source of errors, is suppressed by placing the two microphones sufficiently far apart in the duct. The modal spectra and some of the modal interaction terms (modal correlations) for a number of fans are presented. The method should have many applications in verifying modal propagation, absorption of linings, and scattering of modes, in addition to identifying sound sources.

72-1237

UNDERWATER SOUND PROPAGATION IN THE STRAITS OF FLORIDA: THE PRELIMINARY ANALYSIS OF THE MIMI EXPERIMENT OF 1970

Heitmeyer, R.M.
Mich. Univ., Cooley Electronics Lab., Ann Arbor, Mich. Rept. No. TR-213 (Feb. 1972) 215 pp

Key Words: underwater sound

An underwater acoustic propagation experiment conducted during the month of November 1970 as part of the Project MIMI propagation and signal processing research program is reported. A periodic broadband signal, modulating a 420 HZ carrier was transmitted continuously across the Straits of Florida for 19 days. At the receiving site, the power and phase angle of the carrier, the power in the signal sidebands, and the noise power in the signal band were measured. In addition, the total power and the power spectrum in a narrow band about the carrier line were determined as a measure of the modulation caused by the forward scattered surface reverberation. Finally, the correlation of the received signal with a stored reference was computed to measure the multipath structure and its stability. This report presents a brief description of the acoustical range, the experiment, and preliminary analysis of the data.
AD-737692

72-1238

NEARFIELD SOUND PRESSURE AND VIBRATIONAL VELOCITY IN PLANE WAVE SCATTERING BY A CIRCULAR CYLINDER

Kartavenko, A.I.; Kirshov, V.A.; and Tonakanov, O.S.

Transl. to English from Vestn. Mosk. Univ., No. 4, 376-382 (1971)

Key Words: acoustic scattering, circular cylinders, wave diffraction

The amplitude configuration of the total sound pressure field and vibrational velocity components is computed theoretically for plane wave scattering by acoustically soft and hard cylinders. Results are presented of experimental investigations of the nearfield at a finite cylinder with soft boundaries in a water medium for kr = 1 - 8. Experimental and theoretical data are compared.
N72-14699

72-1239

NEARFIELD RADIATED NOISE STUDY

Murphy, D.A.
Hughes Aircraft Co., Fullerton, Calif.

FR-72-11-6 (Dec. 1971) 53 pp

Key Words: noise measurement, underwater sound

The study consists of three parts. In the first, the estimation of farfield pressure waveform is examined to determine the dependence of the estimator upon the nature of the source. In the second, the effect of surface image interference upon the estimate of radiated noise intensity mean and variance is investigated. In the third part the dependence of the spectrum measurement upon the position in the field of the source is shown to be significant.
AD-736699

72-1240

REFLECTION AND TRANSMISSION OF ACOUSTIC SHOCK WAVE AT A BOUNDARY
Nakamura, A. and Takeuchi, R. (Osaka Univ., Inst. of Sci. and Industrial Res., Yamadakami, Suita, Osaka, Japan)
Acustica 26 (1), 42-50 (Jan. 1972) 10 refs

Key Words: piping, shock waves, sound transmission, sound waves

Measurements are made of the waveform of transmitted sound pulses radiated into free air space from the open end of a circular pipe, when an N-shaped acoustic shock wave propagating through the pipe is incident upon the open end. It is found that a reflected wave has a form which includes mainly lower frequency components of N waveform, but the transmitted waves are made up of two sharp pulses. Calculations are made by the technique of the Fourier analysis for a change of waveform of a pulse at a boundary whose acoustic impedance depends upon frequency. It is assumed that any component of N waveform may behave independently of other components. Reasonable agreements between the calculated and the experimental results is obtained.

72-1241

NOISE FROM TWO-DIMENSIONAL VORTEXES
Sanders, N.D. and Stockman, N.O. (NASA-Lewis Res. Ctr., Cleveland, Ohio)
AIAA 10th Aerosp. Sci. Meeting, San Diego, Calif. (Jan. 17-19, 1972) AIAA Paper No. 72-155, 6 pp, 5 refs

Key Words: vortex noise

The fluctuating flow in an idealized model of a turbulent shear layer composed of many discrete vortexes is analyzed. Computer solutions reveal irregular motions which are similar in many respects to observed flows in turbulent three-dimensional layers. The model is further simplified to a pair of equal corotating vortexes and the noise generation is analyzed in terms of equivalent quadrupole oscillations. Results of the analysis in a uniform medium are consistent with Lighthill's results. New results are obtained for the effects of mean velocity gradients, compressibility, temperature inhomogeneities, and gradients of the mean Mach number.

72-1242

ACOUSTIC NEARFIELD MEASUREMENTS OF A FREE-FLOODED MAGNETOSTRICTIVE RING
Sinsky, J.A.
Naval Res. Lab., Washington, D.C., Rept. No. NRL-7328 (Dec. 1971) 40 pp

Key Words: acoustic measurements, rings, vibrating structures

Precision acoustic nearfield pressure magnitude and phase measurements have been made of a radially oscillating free-flooded cylindrical ring. The measurements demonstrate the potential of the NRL Acoustic Research Tank Facility for careful determination of nearfield pressure magnitude and phase. Various pressure profiles and phase profiles are plotted. Besides demonstrating results possible with the Tank Facility, the profiles are used to derive dynamic properties of the ring. The transmitting efficiency, surface velocity, and radiation impedance of the ring are derived from the nearfield data and are independently confirmed by other methods. Further analysis than that presented here can predict the acoustic interaction through the medium among many rings in an array.
AD-737615

72-1243

MEASUREMENT AND ANALYSIS OF NOISE FROM FOUR AIRCRAFT IN LEVEL FLIGHT
Tanner, C.S.
Hydrospace Res. Corp., San Diego, Calif., FAA-RD-71-83 (Sept. 1971) 60 pp

Key Words: aircraft noise, noise measurement

Measurements of noise from aircraft level flyovers are presented in the form of effective perceived noise level (EPNL) as a function of slant range at the closest point of approach. Four aircraft are investigated, the 727, KC-135, 707-320B, and DC-9. The effort involved acquisition of acoustical meteorological, aircraft tracking, and aircraft operational data. Microphones are located 4 ft above the ground in an array normal to the flight track.
AD-739870

72-1244

THE STRUCTURE OF JET TURBULENCE PRODUCING JET NOISE

Wooldridge, C.E.; Wooten, D.C. and Amaro, A.J. (Ultrasystems Inc., Newport Beach, Calif.)

AIAA 10th Aerosp. Sci. Meeting, San Diego, Calif. (Jan. 17-19, 1972) AIAA Paper No. 72-158, 27 pp, 15 refs

Key Words: aircraft, noise, turbulence

Measurements are presented that characterize the structure of the jet in both the core and the surrounding annular mixing region. Experiments are carried out in a 1.5-in. diam subsonic jet at Mach numbers 0.3, 0.5 and 0.7. The growth of pressure fluctuations within the core from the jet outlet to the end of the jet core is traced through the examination of spectral results. The spectra in the jet core exhibit a peak whose frequency scales with the jet velocity and the jet diameter which is related to a characteristic dimension of the mixing process. A digital data reduction program is used to calculate the auto- and cross-correlations of axial velocity fluctuations. In the core the cross-correlations are nearly constant in the space-time plane indicating a traveling pressure wave, while in the annular mixing region the cross-correlations exhibit the usual decay in the space-time plane characteristic of convected turbulence.

72-1245

TRANSPORTATION NOISE AND NOISE FROM EQUIPMENT POWERED BY INTERNAL COMBUSTION ENGINES

Wyle Labs., Spons. by U.S. Environ. Protection Agcy., Office of Noise Abatement and Control, Washington, D.C., NTID300.13 (Dec. 1971) 335 pp

Key Words: noise reduction

The undesirability or desirability of noise in the environment must be judged with reference to its effects on man's basic and intellectual perceptions and actions. Consequently, the goals for noise control must be designed such that the desirable qualities are retained and the undesirable qualities are minimized. To provide a clear understanding of the significance of noise on our environment, several aspects are considered: nature and economic significance of the associated industry; basic noise characteristics of each type of source; environmental noise attributes of each; past and present efforts toward reducing noise; and estimated potential noise reduction for the future with today's technology.

72-1246

COMMUNITY NOISE

Wyle Labs., Spons. by U.S. Environ. Protection Agcy., Office of Noise Abatement and Control, Washington, D.C., NTID300.3 (Dec. 1971) 203 pp, 47 refs

Key Words: noise tolerance

Outdoor noise in the community is investigated. Backup to the summary material in the EPA report is provided.

PB 207124

72-1247

THEORY OF STEADY STATE URBAN NOISE FOR AN IDEAL HOMOGENEOUS CITY

Shaw, E.A.G. and Olson, N. (Natl. Res. Council of Canada, Ottawa, Canada)

J. Acoust. Soc. Amer. 51 (6), 1781-1793 (June 1972) 25 refs

Key Words: noise transmission, traffic noise, urban noise

The city is treated as a plane surface with many identical sound sources (motor vehicles) randomly distributed over its area. The mean energy density at any point in the plane is expressed in terms of the individual source strength, the average number of sources per unit area N, the atmospheric absorption constant α, and a shielding factor F associated primarily with obstacles in the transmission path. The observed octave-band sound pressure levels from 31.5 to 4000 Hz at one location in Ottawa are compared with calculated levels based on statistical data.

72-1248

NOISE FROM CONSTRUCTION EQUIPMENT AND OPERATIONS, BUILDING EQUIPMENT AND HOME APPLIANCES

Bolt Beranek and Newman, Spons. by U.S. Environ. Protection Agcy., Office of Noise Abatement and Control, Washington, D.C., NTID300.1 (Dec. 1971) 138 pp, 39 refs

Key Words: noise reduction, noise tolerance

Noise characteristics of construction, appliances, and building equipment, the influence of this noise on our lives, and the nature of the industries producing and using this machinery are examined. Findings are summarized and a balanced noise abatement program that may be pursued by EPA is recommended.

PERIODIC

(Also see Nos. 1201, 1387)

RANDOM

(Also see Nos. 1219, 1335)

SEISMIC

(Also see Nos. 1224, 1347, 1348, 1349, 1350, 1365)

72-1249

A COMPARATIVE STUDY OF THE ELASTIC WAVE RADIATION FROM EARTHQUAKES AND UNDERGROUND EARTHQUAKES AND UNDERGROUND EXPLOSIONS

Lambert, D.G.; Flinn, E.A.; and Archambeau, C.B.
Teledyne Geotech., Seismic Data Lab., Alexandria, Va., SDL-284 (Oct. 1971) 90 pp

Key Words: earthquakes, sound waves, underground explosions, wave propagation

A detailed analysis of the surface wave radiation from two underground explosions (BILBY and SHOAL) and an earthquake (near Fallon, Nevada) whose epicenter is only 60 km from SHOAL is presented. At long periods the surface wave radiation from the earthquake can be explained by a pure quadrupole (double-couple) source, but at higher frequencies the radiation pattern shows asymmetries which suggest effects due to rupture propagation which require higher order multipole terms in the source equivalent representation. The surface waves from the explosions can be explained by superposed monopole and quadrupole sources, with no indication of higher order multipole terms. A principal conclusion of the study is that the anomalous radiation from explosions is attributable to stress relaxation around the shock-generated shatter zone and not caused by earthquake triggering.
AD-737125

SHOCK

(Also see Nos. 1336, 1362, 1379, 1383)

72-1250

ON THE STATIONARY IMPACT VIBRATION OF A MECHANICAL SYSTEM WITH TWO DEGREES OF FREEDOM

Irie, T. and Fukaya, K.-I. (Faculty of Engr., Hokkaido Univ., Sapporo, Japan)
Bull. JSME 15(81), 299-306 (Mar. 1972) 9 refs

Key Words: harmonic excitation, mechanical systems

A theoretical study of stationary impact vibrations in a mechanical system with two degrees of freedom that consists of two masses with a clearance is presented. The conditions for maintaining stable periodic vibrations are analyzed and ranges of parameters are determined where asymptotic stability is assured. The results show that stable fundamental impact vibration occurs in a wide range of the exciting frequencies when the clearance between the two masses is close to the exciting displacement, a subimpact vibration occurs when the frequency is high, and a double impact vibration occurs as the frequency becomes low.

GENERAL WEAPON

72-1251

PREDICTION OF GROUND SHOCK INDUCED AIRBLAST OVERPRESSURES FOR SUBSURFACE EXPLOSIONS FROM PEAK VERTICAL SPALL VELOCITY

Snell, C.M. and Oltmans, D.L.
Army Engr. Explosive Excavation Res. Office, Livermore, Calif., EERO-TR-40 (Nov. 1971) 67 pp

Key Words: airblasts, nuclear explosions, underground explosions

A technique is presented for the prediction of ground shock induced airblast overpressures resulting from the subsurface detonation of nuclear and chemical explosives. The technique is based on a theory and physical model, developed by D.N. Montan of the Lawrence Livermore Laboratory, which correlates ground shock induced airblast overpressures with the vertical velocity of the rising mound above the detonation point. The derivation of the theory is reviewed in detail and the model's predictions are compared with airblast overpressure values measured during almost a score of large yield chemical and nuclear detonations. Appendixes provide supplementary information on the correlation between vertical surface velocities and induced overpressures, extend the theory to five- and seven-charge row detonations, and apply the theory to contained and mounding detonations and to detonations in a noncompetent saturated medium overlain with water.
AD-739509

72-1252

ASSESSMENTS OF HOUSE DAMAGE FROM EVENT DIAL PACK AND 100 TON AN/FO TEST
Wilton, C.
URS Research Co., San Mateo, Calif., URS-788-2 (Mar. 1972) 64 pp

Key Words: blast excitation, buildings, explosions

The report summarizes the damage sustained by a two-story wood frame house when exposed: (1) to a peak incident overpressure of about 1.6 psi from the explosion of a hemispherical charge of Ammonium Nitrate/Fuel Oil (AN/FO) weighing 100 tons; and (2) after being moved and repaired, to a peak incident overpressure of about 2.7 psi from the explosion of a 500 ton spherical charge of TNT tangent to the ground surface (Event Dial Pack). A moderate amount of damage (including considerable roof rafter damage) is noted after the AN/FO test; considerably more damage (including breakage of all roof rafters) is noted after the Dial Pack test.
AD-739371

PHENOMENOLOGY

COMPOSITE

(Also see Nos. 1327, 1400)

DAMPING

(Also see Nos. 1211, 1262, 1263, 1281, 1282, 1299, 1313, 1335, 1389, 1390, 1405)

72-1253

RELATION BETWEEN AVERAGE DAMPING AND SURFACE DAMPING AT MATERIAL OSCILLATORS UNDER CONSIDERATION OF THE GEOMETRY
Troost, A. and Betten, J. (Instituts fuer Werkstoffkunde (Lehrstuhl A) der T.H. Aachen)
VDI Z. 114(5), 336-338 (Apr. 1972) 4 refs

Key Words: material damping, oscillators

The relations between the damping averaged over the sample volume or the structural part volume and the damping at the location under the highest stress were previously known only for test bars with rectangular or circular cross section. Recalculation equations of general validity are established. The method is not restricted to the material damping but can be also used, for instance, for the evaluation of the edge bending stress at overelastic bending. (In German)

ELASTIC

(Also see No. 1277)

72-1254

THE EFFECT OF COUPLE STRESSES ON THE DYNAMIC STRESS CONCENTRATION AROUND A CRACK
Itou, S. (Tohoku Univ., Sendai, Japan)
Intl. J. Engr. Sci. 10(4), 393-400 (Apr. 1972) 11 refs

Key Words: cracked structures

The dynamic problem is presented for an infinite elastic Cosserat medium weakened by a finite crack where the self-equilibrated system of pressure is varying harmonically in time. There are two sets of mixed boundary values and the problem is reduced to four simultaneous integral equations which are solved by the series method. The numerical examples are carried out to clarify the effect of couple stresses on the dynamic stress concentration around a crack.

72-1255

RESPONSE OF ELASTIC MEDIA WITH A CYLINDRICAL CAVITY TO DYNAMIC AND IMPACT LOAD
Shibahara, M. and Kojima, M. (Faculty of Engr., Kanazawa Univ., Kanazawa, Japan)
Bull. JSME 15(81), 281-285 (Mar. 1972) 7 refs

Key Words: cavities, dynamic response, elastic medium, Fourier transformation

The Fourier transform technique and the theory of distributions are applied to the analysis of dynamic and impact responses of cylindrical cavity in infinite elastic medium. The relationship between dynamic and impact responses are discussed by means of the periodicity of loading, i.e., the parameter of Fourier transformation.

FLUID

(Also see Nos. 1226, 1237, 1274, 1278, 1301, 1308, 1309, 1323, 1336, 1396)

72-1256

DYNAMIC RESPONSE OF SUSPENDED UNDERWATER SYSTEMS

Iwan, W.D. (Calif. Inst. Tech., Div. Engr. and Appl. Sci., Pasadena, Calif.)

J. Acoust. Soc. Amer. 51 (5), 1688-1696 (May 1972) 11 refs

Key Words: heave response, offshore structures, periodic response, random response

A method is presented for analyzing the steady state or stationary random heave response of suspended underwater systems. The nonlinear continuous system is replaced by a discretized pseudolinear system by means of an equation difference minimization technique. The resulting pseudolinear system is solved by an iterative scheme. An example of the application of the proposed method of analysis to a suspended hydrophone system is given. The example shows that the nonlinear pressure drag forces have a very significant effect on the overall response of the system. The nature of the response is discussed and some practical conclusions are given.

72-1257

UNDERWATER SHOCK WAVE PRESSURES FROM SMALL DETONATORS

Poche, L.B., Jr. (Naval Res. Lab., Underwater Sound Reference Div., Orlando, Fla.)

J. Acoust. Soc. Amer. 51 (5), 1733-1737 (May 1972) 8 refs

Key Words: shock wave propagation, test data, underwater explosions

Shock wave peak pressures produced by exploding small (13.5 gr) detonators underwater measured at ranges from 1 to 90 ft are reported. Good agreement with the empirical pressure-distance scaling rule for TNT is found, and spreading of the pressure-time profile with range is found. Confidence limits for the predicted peak pressures at [illegible] anges are given. The data are fitted to two other pressure-distance functions based on the Kirkwood-Bethe propagation theory.

72-1258

UNDERWATER AUDIOFREQUENCY TRANSMISSION AS A FUNCTION OF SIMULATED DISTANCE (IN MODELS)

Rhodes, R.A., II; Hollien, H.; Rothman, H.; and Feinstein, S.
Fla. Univ., Gainsville, Fla., Rept. No. CSL/ONR-13 (Dec. 1971) 7 pp

Key Words: ultrasonic tests, underwater tests

The ultrasonic modeling technique is being used to investigate sound propagation in the shallow ocean in connection with a project on the basic aspects of underwater speech and hearing. The ultrasonic simulation experiment is carried out in a water-filled concrete tank 3 ft x 4 ft x 4 in. side lined with sound absorbing rubber matting and bottom lined with soft rubber to simulate sand. The electroacoustical transducers are a matched pair of lead zirconite-titanate piezoelectric crystals of frequency 400 kHz with wire probes projecting beneath the water surface. One problem simulated is one in which field measurements were previously taken at 16 frequencies from 0.10 kHz to 5 kHz in the Gulf of Mexico and in 31 meters of 76F water over a flat sandy bottom. The modeling experiment simulates these 15 frequencies with a single frequency by appropriate distance scaling.
AD-737746

INELASTIC

(Also see No. 1314)

SOIL

72-1259

DYNAMIC STUDIES ON THE BEARING CAPACITY OF PILES -- PHASE III: VOLUME I

Goble, G.G.; Rausche, F.; and Moses, F.
Case Western Reserve Univ. Cleveland, Ohio, Rept. No. 48-Vol-1 (Aug. 1970) 179 pp

Key Words: computer programs, interaction: structure medium, pile driving

An automated prediction scheme is presented which uses both measured force and acceleration at the top of the pile as input and computes the soil resistance forces acting on the pile during driving. The distribution of these resistance forces acting along the pile is also determined. Shear and dynamic resistance forces are distinguished such that a prediction of total static bearing capacity is possible. Using the shear force prediction, the authors compute the static

load vs penetration curve for comparison with the result from a corresponding field static load test. Two simplified methods are developed for predicting static bearing capacity from acceleration and force measurements. These methods can be used during field operations for construction control when incorporated in a special purpose computer.
PB 207228

72-1260

DYNAMIC STUDIES ON THE BEARING CAPACITY OF PILES -- PHASE III: VOLUME II
Goble, G.G.; Rausche, F.; and Moses, F.
Case Western Reserve Univ., Cleveland, Ohio, Rept. No. 48-Vol-2 (Aug. 1970) 159 pp

Key Words: computer programs, dynamic response, interaction: structure-medium, pile driving

The automated prediction scheme presented in Vol. I is further described. The soil resistance forces acting on the pile during driving are computed.
PB 207229

72-1261

EFFECT OF FOUNDATION EMBEDMENT ON THE DYNAMIC BEHAVIOR OF THE FOUNDATION-SOIL SYSTEM
Gupta, B.N. (Maulana Azad Col. Tech., Bhopal-7 (M.P.), India)
Geotechnique 22 (1), 129-137 (Mar. 1972) 4 refs

Key Words: interaction: structure-medium, test models

Foundation embedment is one of the factors not considered in the analysis of foundations subjected to dynamic loads either by elastic half-space theory or by a lumped parameter system. Model tests are conducted on eight model footings, four of which have the same shape, equal weights and different areas; whereas the other four have equal areas and weights but different shapes. The effect of foundation embedment on resonant frequency, resonant amplitude, spring constant and damping factor of the foundation-soil system is studied. Instrumentation and experimental details are explained. The test results are discussed and conclusions are drawn.

72-1262

SHEAR MODULUS AND DAMPING IN SOILS: MEASUREMENT AND PARAMETER EFFECTS
Hardin, B.O. and Drnevich, V.P. (Civil Engr., Univ. Ky., Lexington, Ky.)
ASCE J. Soil Mech. Found. Div. 98 (6), 603-624 (June 1972) 25 refs

Key Words: damping, shear modulus, soils, vibration excitation

Note: For the Report of this material see Abstract No. 71-85.

Numerous tests on a spectrum of disturbed and undisturbed soils show that the shear modulus decreases and the damping ratio increases very rapidly with increasing strain amplitude. The rate of increase or decrease depends on many parameters: (1) effective mean principal stress; (2) degree of saturation; (3) void ratio; and (4) number of cycles of loading. Ambient states of octahedral shear stress, overconsolidation ratio, effective strength envelope, frequency of loading, and time effects have a less important influence on these properties. Cohesive soils are affected differently than clean sands. The apparatus used to measure shear modulus and damping must be capable of making accurate measurements at very small shearing strains, the range being defined by practical problems in earthquake and foundation vibrations. A pseudostatic simple shear apparatus and two different resonant column apparatus were used.

THERMOELASTIC

(Also see No. 1299)

VISCOELASTIC

(Also see Nos. 1225, 1310)

72-1263

NOISE AND VIBRATION CONTROL BY VISCOELASTIC DAMPING
Hooker, R.J. (Dept. Mech. Engr., Univ. Queensland, Australia)
J. Inst. Engr. Aust. 44 (3), 9-11 (Mar. 1972) 7 refs

Key Words: noise reduction, vibration control, viscoelastic damping

This article is the third of a series of introductory articles for the nonspecialist aimed at elucidating the extent to which vibration can presently be controlled.

EXPERIMENTATION

DIAGNOSTICS

72-1264

ACOUSTIC SIGNAL ANALYSIS FOR NOISE SOURCE IDENTIFICATION IN MECHANISMS
Peterson, R.H.; Ackerman, A.D.; and Zelenski, R.E. (IBM General Systems Div. Lab., Rochester, Minn.)
IBM J. Res. Dev. 16(3), 249-257 (May 1972) 4 refs

Key Words: acoustic detectors, analog computation, machinery noise

Proper interpretation of the time and frequency characteristics of machine noise provides information useful in identifying and quantifying noise sources in complex mechanisms. The use of commercial acoustic instrumentation led to the development of unique analog instrumentation for noise-time analysis and ultimately to a real time analog-digital signal analysis capability. The hybrid system described in this paper provides the time and frequency resolution necessary for noise source identification and evaluation.

EQUIPMENT

72-1265

MULTIAXIAL SERVOHYDRAULIC TEST BEDS FOR DYNAMIC STRENGTH TESTS ON MOTOR VEHICLE AXLES
Klinger, F. and Ross R. (Carl Schenck Maschinenfabrik, G.m.C.H., Darmstadt, Germany)
Automobiltech. Z. 74(4), 139-145 (Apr. 1972) 4 refs

Key Words: automobiles, dynamic testing, test facilities

The forces acting on the wheel during a ride continuously change in size and direction. Several servohydraulic test cylinders and rotary drives must be installed in order to simulate this behavior on a test stand for the investigation of vibration stability of wheel mounts, vehicle axles and automobile bodies. Since separate cylinders interact mutually, the construction of a multiaxial test stand requires a solution of a series of problems in automatic control technology. In addition, the test cylinder arrangement and location of action of force has to be determined. These problems are discussed. (In German)

72-1266

FIXTURE FOR SUPPORTING ARTICLES DURING VIBRATION TESTS
Light, D.J. (Natl. Aeronaut. and Space Admin., Marshall Space Flight Ctr., Huntsville, Ala.)
NASA-Case-MFS-20523 (Oct. 1970) (U.S. Patent Appl. SN 77786) 12 pp

Key Words: testing facilities, vibration testing

A fixture is described for supporting and securing articles, such as electrical components, during vibration testing of the articles. An integral annular unit with series of spaced blind cavities in its top surface and around the outer surface makes up the fixture. Articles to be tested are secured in the cavities of the fixture, and the fixture is mounted on the driver head of a vibration exciter whereby the fixture is aligned with the driver coil of the exciter. The cavities may be in the form of partially threaded bores with an intermediate shoulder to receive a disk and a clamping nut for securing test items in the bores.
N72-15425

72-1267

A NEW PORTABLE SOUND VIBRATION ANALYSIS AND RECORDING SYSTEM
Kundert, W.R. and Marteney, E.R. (Gen. Radio Co., Concord, Mass.)
S/V Sound and Vib. 6(4), 14, 16 (Apr. 1972)

Key Words: sound recording, vibration recording

A new portable sound-analysis system is described. Particular attention has been given to packaging and providing operational simplicity and convenience. The analyzer weighs 5-12 lb and can be comfortably held in one hand and operated with the other. The system consists of three major components: a precision sound-level meter and analyzer, a magnetic tape recorder, and a power supply and charger.

72-1268

TORSIONAL OSCILLATIONS
Waddell, P. (Univ. Strathclyde, Mech. Engr. Group)
EM&D J. Engr. Mater. Des. 15(5), 398-401 (May 1972) 5 refs

Key Words: holographic techniques, interferometers, torsional response

Holographic techniques are used to examine torsional oscillations. An electrical torsional vibratory is used to excite the natural modes.

INSTRUMENTATION

(Also see No. 1267)

72-1269

WIDE-RANGE CALIBRATION SYSTEM FOR PRESSURE-GRADIENT HYDROPHONES
Bauer, B.B.; Abbagnaro, L.A.; and Schumann, J. (CBS Labs., Stanford, Conn.)
J. Acoust. Soc. Amer. 51(5), 1717-1724 (May 1972) 3 refs

Key Words: calibrating, hydrophones, underwater sound

A gradient hydrophone calibrator consists of a precisely made water-filled tank which is set into axial oscillation with suitable drivers to develop a standing wave of sound in the water. The tank has ports to receive the hydrophones to be calibrated and the reference pressure hydrophones. An improved calibrator is described which covers a range of 3 to 2500 Hz. Measurements are simplified through the use of electrical feedback, which maintains a constant pressure-gradient vs frequency function. The applications and limitations of this system to the measurement of sensitivity, frequency response, and phase response of pressure-gradient and pressure hydrophones, and for obtaining the polar patterns of gradient hydrophones, are described.

72-1270

MONITORING MICROINCH DISPLACEMENTS IN ULTRASONIC WELDING EQUIPMENT
Crispi, F.J.; Maling, G.C., Jr.; and Rzant, A.W. (IBM Syst. Manufacturing Div. Plant, Poughkeepsie, N.Y.)
IBM J. Res. Develop. 16(3), 307-312 (May 1972) 5 refs

Key Words: dynamic testing, measurement techniques, ultrasonic welding

Two noncontacting techniques for dynamic measurement of high-frequency microinch displacements are described which have been applied in monitoring the dynamic displacement of the magnetostrictive transducer system used in ultrasonic welding. One technique consists of a light reflecting scheme that uses a fine fiber optic probe. The probes are available in a range of sizes and, in general, can be used to measure displacements of from 0 to 0.030 in. at low frequencies and from 5 to 5000 μin. at any frequency below 100 kHz. The second method, an acoustical technique, leads to results similar to those obtained with the reflective system and can be used with a 0.030 in. diam acoustic probe; this technique has been used in a frequency range well above that usually associated with probe tube measurements.

72-1271

FREQUENCY CHARACTERISTICS OF A COMPENSATED-CAPACITANCE PIEZOELECTRIC CERAMIC RECEIVER
Domarkas, V.I. and Kazhis, R.-I. Yu. (Kaunas Polytechnic Inst., Kaunas, Lithuania)
Sov. Phys., Acoust. 17(4), 514-515 (Apr./June 1972) (Engl. Transl. Akust. Zh. 17(4), 610-611, Oct./Dec. 1971) 2 refs

Key Words: frequency response, piezoelectric plates

The frequency characteristics of a piezoelectric receiver in the form of a plate may be described by the transfer function $K_n = U/p$, where U is the voltage on the faces of the piezoelectric plate when driven by a vibratory pressure p. For a piezoelectric receiver without coupling layers and with the capacitance of the piezoelectric plate completely compensated at each frequency the transfer functions takes a certain form. These characteristics are discussed.

72-1272

LOAD CELL FOR MEASUREMENT OF STATIC AND DYNAMIC LOADS AT EXCITATION OF OSCILLATIONS IN MACHINE PARTS
El Hakim, M.A. (Technische Hochschule "Otto von Güricke", Sektion Technologie der metalverarbeitenden Industrie, Magdeburg, Germany)
Maschinenbautechnik 21(3), 103-105 (Mar. 1972) 6 refs

Key Words: dynamic excitation, machinery, measuring instruments

A load cell developed for measurement of the static contact force and the dynamic excitation load at oscillating generation by means of an oscillation generator is described. It is distinguished by a large linear nearly hysteresis free range, flat frequency response and high sensitivity. (In German)

72-1273

ZERO-SHIFT OF ELECTRICAL SUSPENSION POINTER INSTRUMENTS
Merz, E. (D-68 Mannheim 42, Pommernstr. 45, Deutschland)
Ing. Arch. 41(3), 168-193 (1972) 14 refs

Key Words: measuring instruments, shock response, vibration response

Former studies dealing with the zero-shift of jeweled bearing pointer instruments as caused by deterministic and stochastic vibration have

been carried on to taut suspension pointer instruments. These are becoming increasingly important in practice because of their ridigity and operating reliability. (In German)

72-1274

A NEW CAPPED-CYLINDER DESIGN FOR AN UNDERWATER SOUND TRANSDUCER (USRD TYPE F50)
Tims, A.C. (Underwater Sound Reference Div., Naval Res. Lab., Orlando, Fla.)
J. Acoust. Soc. Amer. 51(5), 1751-1758 (May 1972) 4 refs

Key Words: transducers, underwater sound

A small broadband transducer is described which was developed primarily for use as a receiver in the frequency range 1 Hz to 70 kHz, but it can be used also as a sound source in the frequency range 10 to 70 kHz. The nominal free-field voltage sensitivity at the end of a 30.5 m cable is – 205.9 db re 1 V/μPa at frequencies below 10 kHz. As a sound source, the transducer is linear with driving voltage to 200 V CW at frequencies from 10 to 60 kHz. The broadband characteristics are attributed to the novel design of the sensor element, a design that is applicable to a variety of cylindrical sensor configurations.

72-1276

XB-70 AERODYNAMIC, GEOMETRIC, MASS, AND SYMMETRIC STRUCTURAL MODE DATA
Wykes, J.H. and Mori, A.S.
No. Amer. Aviation, Inc., Los Angeles, Calif., NASA-CR-116773 (Mar. 1970) 93 pp

Key Words: aircraft, modal analysis

Mass, structural, and aerodynamic data for the XB-70-1 are updated to reflect as closely as possible the characteristics of the airplane at three specific flight conditions which are actually flown. A nominal Mach number of 0.90 at an altitude of 25,000 ft (two cases) and a nominal Mach number of 1.6 at an altitude of 40,000 ft (one case) are used. In-flight response characteristics at a number of points on the vehicle are obtained by exciting a pair of shaker vanes on the noise of the airplane. Data are recorded with the basic stability augmentation system (SAS) operating both alone and together with the identical location of accelerometer and force (ILAF) structural mode control system. Detailed total vehicle weight, mass characteristics, structural frequencies, generalized masses, all aerodynamic data used in the present analyses, and a description of the actual mode shapes are tabulated and presented.
N72-14998

PROCEDURES

(Also see No. 1235)

72-1275

CONSIDERATIONS IN THE DEVELOPMENT OF MEASUREMENT PROCEDURES FOR THE REGULATION AND MONITORING OF NOISE POLLUTION
Leasure, W.A., Jr.
Natl. Bur. Standards, Washington, D.C., AIAA Paper No. 72-622

Key Words: automobiles, noise measurement, standards

A noise standard or regulation should be based on accurate, reliable and relevant measurements. In this paper, some of the basic considerations in developing measurement systems which are required in order to effectively regulate or monitor noise pollution or to assess the alternative strategies for noise abatement and control are outlined. The importance of these considerations is reinforced through a detailed discussion of the questions addressed during the design of a test procedure and measurement methodology for a specific research program in the area of motor vehicle noise.

SCALING AND MODELING

(Also see No. 1381)

TECHNIQUES

(Also see Nos. 1242, 1329)

72-1277

DETERMINATION OF THIRD- AND FOURTH-ORDER LONGITUDINAL ELASTIC CONSTANTS BY SHOCK COMPRESSION TECHNIQUES-APPLICATION TO SAPPHIRE AND FUZED QUARTZ
Graham, R.A. (Sandia Labs., Albuquerque, N. Mex.)
J. Acoust. Soc. Amer. 51(5), 1576-1581 (May 1972) 41 refs

Key Words: shock wave propagation

A number of solids sustain large elastic compressions under shock wave loading. In these solids, measurements of the stress and compression in the direction of shock propagation can be used to calculate both third- and fourth-order longitudinal elastic constants if measurements are carried out over a wide range of compressions. Only limited measurements of fourth-order constants have been previously determined

by other techniques. Determinations of third-order constants under these large elastic compressions afford the opportunity to test the applicability of the finite strain formulation of constitutive relations. A general method for calculating these third- and fourth-order constants is presented and applied to shock compression data for sapphire and fuzed quartz. The technique and method of analysis seem generally applicable to solids that exhibit elastic limits of a few percent of their longitudinal elastic constants.

72-1278

ULTRASONIC METHOD OF DETERMINING THE SHEAR RESISTANCE OF HYDRAULIC FLUIDS AND LUBRICATION OILS
Wislicki, B. and Karpinski, W.
Unedited rough draft trans. of Instytut Lotnictwa. Prace (Poland) No. 41, 67-94 (1970) 31 pp

Key Words: cavity effect, lubrication, ultrasonic tests

A description is given of an ultrasonic method for studying the resistance of hydraulic fluids and lubrication oils to the action of mechanical shear forces. The effectiveness of the method is studied as a function of power (up to 200 W) and frequency (10, 15, and 20 kHz) using acoustical concentrators in the form of an exponential horn, a disk ended exponential horn, a stepped cylindrical concentrator, and a chamber concentrator. Shearing efficiency is determined photographically. The ultrasonic method is compared for mineral and synthetic oils with pump slot techniques using injection pumps and gear pumps. The shear kinetics are analyzed, and relations are given for calculating viscosity on the basis of a given shear time.
AD-736885

COMPONENTS

ABSORBERS

(Also see No. 1386)

72-1279

SHOCK ABSORBING DEVICE
Topits, A., Jr. (Jet Propulsion Lab., Calif. Inst. Tech., Pasadena, Calif.)
NASA-Case-NPO-10626 (June 1970) 13 pp

Key Words: bearings, shock absorber

A shock absorber for supporting bearings subjected to omnidirectional shock loading in a high acceleration of gravity environment is described. The device includes a pair of annular parts arranged in a concentric relationship and interconnected through several radially directed, shock absorbing parts of an ogee configuration. These parts serve to couple the annular parts into a unitary structure so that an annular bearing race can be mounted on the innermost part and supported in a coaxial relationship with it, while the device operatively is supported at the surface of the outermost annular part. Consequently, each shock absorbing part is stressed independently as a shock loading of the device occurs. Due to their ogee configuration, the shock absorbing parts concurrently are strained and may simultaneously experience elongation, contraction, and rolling for dissipating stress-inducing shock loads, regardless of the direction of forces applied during shock loading of the device.
N72-15465

BEAMS, STRINGS, RODS

(Also see Nos. 1221, 1302)

72-1280

PASSBANDS FOR ACOUSTIC TRANSMISSION IN AN IDEALIZED DRILL STRING
Barnes, T.G. and Kirkwood, B.R. (Univ. Tex. at El Paso, El Paso, Tex.)
J. Acoust. Soc. Amer. 51 (5), 1606-1608 (May 1972) 4 refs

Key Words: drill strings, longitudinal response, torsional response

A comparative analysis is given for zero mode transmission of torsional and longitudinal harmonic waves in an idealized drill string of uniform pipe sections with uniform coupling joints. Multiple passbands are shown to exist with successively increasing and then decreasing bandwidths. The longitudinal wave passbands have the wider maximum pass bandwidths but successively occur at higher frequencies where a nonidealized system may have more attenuation.

72-1281

THE EFFECT OF FRICTIONAL DAMPING ON THE VIBRATION OF AN ELASTICALLY SUPPORTED BEAM
Beards, C.F. and Bermingham, P.J. (Imperial College, London, England)
Symp. on Nonlinear Dynamics held at Loughborough Univ. Tech., England (Mar. 27-28, 1972) 5 refs

Key Words: beams, Coulomb friction, vibration response

The vibration characteristics of a structure are shown to be dramatically affected by optimizing the frictional damping occurring because of relative slip between contacting joint interfaces. Experimental amplitude-frequency responses for several modes of vibration of an elastically supported beam with frictional damping are presented, together with the predictions for a simple linearized model. The model is useful for predicting some features of the response without becoming embroiled in stick-slip theory and changes in the coefficient of friction. The friction force occurring in the joint for minimum resonant amplitude response is shown to be independent of the beam support stiffness and the damper support stiffness, although the latter should be as high as possible. This friction force is greater than that which results in maximum energy dissipation in the joint.

72-1282

DAMPING OF TORSIONAL VIBRATIONS IN CIRCULAR RODS
Nikiforov, A.S.
Sov. Phys., Acoust. 17 (4), 521-522 (Apr./June 1972) (Engl. Transl. Akust. Zh. 17 (4), 615-617 (Oct./Dec. 1971)) 2 refs

Key Words: beams, rods, torsional vibration, viscoelastic damping

The author studies the damping of torsional vibrations in beam structures of circular cross section (rods) and determines the loss factor in the rods when their surface is coated with a uniform thickness layer of a viscoelastic material.

72-1283

DYNAMIC STABILITY OF THIN WALLED BARS WITH OPEN SECTION
Popescu, N.D.
Struct. Engr. 50 (3) p. 135 (Mar. 1972)

Key Words: bars, dynamic stability

A study is presented on the dynamic stability of thin walled bars with open cross section subjected to compression by an axial force, composed from a static component and a variable one. The case of nonsymmetric profiles is analyzed in the first instance to obtain general equations of vibratory motions; these are then particularized for profiles with an axis of symmetry. Differential equations are established and solved which define the vibratory motion of the axis of the bars. Similarly the stability and instability of the solutions to these equations are studied.

72-1284

RANDOM DEFLECTIONS OF A STRING ON AN ELASTIC FOUNDATION
Sanders, J.L., Jr. (Harvard Univ., Cambridge, Mass.)
SIAM J. Appl. Math. 22 (3), 406-418 (May 1972) 6 refs

Key Words: elastic foundations, random response, strings

The problem of a taut string on a random elastic foundation subjected to random loads is investigated. The boundary value problem is transformed into an initial value problem by the method of invariant imbedding. Fodder-Planck equations for the random initial value problem are formulated and solved in some special cases. The analysis leads to a complete characterization of the random deflection function.

72-1285

ANALYSIS OF NONLINEAR TRANSIENT MOTION OF CABLES USING BOND GRAPH METHOD
Tsai, N.T. (Litton Ship Systems-AMTD, Culver City, Calif.)
J. Engr. Indus., Trans. ASME 94 (2), 500-506 (May 1972) 18 refs

Key Words: cables, digital simulation, fluid-induced excitation, submerged structures, transient response

The dynamic motion of underwater cable systems under hydrodynamic load is investigated using the system formulation of the bond graph technique. The cable system can be a single mooring line or a multimooring system with nonuniform cables. The dynamic behavior of the cable systems caused by fluid flow excitations, such as strumming force and surface waves, is calculated by using digital simulation programs. The result shows that the complicated transient motion of underwater cable systems can be treated successfully with this technique.

72-1286

ON THE MOTION OF A CURVED AND TWISTED ROD
Tso, W.K.
Acta Mech. 13 (3-4), 163-178 (1972) 5 refs

Key Words: curved rods, equations of motion

The equations of motion of a curved and twisted rod are derived from the basic principles of dynamics. The set of equations gives the extensional, flexural and torsional motions of the rod. The coupling among these types of motion because

of the curvature and tortuosity of the rod is shown explicitly in the case of a helical spring. By successive simplification of the equations, the equations of motion of a circular ring and those of a straight rod are obtained. In this respect, the derived equations can be considered as a generalization of the elementary theories of rod in extensional, torsional and flexural motion. The dispersion relation of a helical spring is calculated for the two lower frequency modes. It is shown that the frequency-wavelength relationship is not monotonically decreasing as in the cases of uncoupled flexural or torsional motion. Finally, frequencies are calculated based on the approximate frequency expression of Love to show that Love's frequency expression for a helical rod is accurate.

72-1287

A TWO DEGREE-OF-FREEDOM MODEL FOR THE TWO-DIMENSIONAL DYNAMIC MOTIONS OF SUSPENDED EXTENSIBLE CABLE SYSTEMS
Wang, H. T.
Naval Ship Res. and Dev. Ctr., Bethesda, Md., Rept. No. NSRDC-3663 (Oct. 1971) 46 pp

Key Words: cables (ropes), dynamic response

A two degree-of-freedom nonlinear model is presented for the two-dimensional dynamic motions of an extensible suspended cable system. The two degrees of freedom are the stretch and inclination of the cable. The dynamic and drag characteristics of the cable are carefully modeled. The equations of motion are derived by means of the Lagrange equations. The potential and kinetic energies of the cable are obtained by assuming that the cable stretches uniformly. To account for ocean wave particle velocities and current profiles which may vary with depth, the cable may be divided into an arbitrary number of segments to calculate normal and tangential drag. The phenomenon of cable slack is also modeled. Numerical results from the program compare favorably with experimental measurements.
AD-737998

BEARINGS

72-1288

STABILITY AND TRANS ENT MOTION OF A VERTICAL THREE-LOBE BEARING SYSTEM
Falkenhagen, G. L.; Gunter, E. J.; and Schuller, F. T. (Dept. Mech. Engr., Univ. Idaho, Moscow, Idaho)
J. Engr. Indus., Trans. ASME 94 (2), 665-677 (May 1972) 20 refs

Key Words: bearings, stability, transient response

The stability characteristics and general transient motion of the finite width three-lobe bearing assuming an incompressible fluid with cavitation are presented. The hydrodynamic bearing forces are evaluated by both a finite difference analysis and an approximate method. The approximate method consists of the infinite bearing solution corrected for end leakage. The approximate method is compared to the finite difference solution of Reynolds equations and yields acceptable accuracy while running 100 times faster. Linearized bearing stiffness and damping coefficients are determined numerically and used to calculate the threshold of instability for a rigid vertical rotor. The stability curves developed are compared to NASA experimental data and analytic work performed by Lund. The nonlinear transient orbits for a balanced rotor are computed and plotted for comparison to the linear stability curves and the NASA test data. The influence of rotor unbalance above and below the stability threshold is investigated. The stability of the three-lobe bearing is optimized with respect to minimum film thickness. It is found that the optimum preload factor varies from 0.59 to 0.47 and the corresponding offset factor ranges from 0.8 to 1.0 for an aspect ratio $L/D = 1.0$.

72-1289

SLIP AND CARGO FORCES IN A HIGH-SPEED ROLLER BEARING
Poplawski, J. V. (Homer Res. Labs., Bethlehem Steel Corp., Bethlehem, Pa.)
J. Lubric. Tech., Trans. ASME 94 (2), 143-152 (Apr. 1972) 6 refs

Key Words: roller bearings, test models

A roller bearing model is described which was developed for use in estimating cage slip, roller slip, film thickness, and cage forces for a given bearing geometry and operating condition. The model includes churning loss, cage pilot surface friction, roller pocket friction, cage unbalance and the drag caused by the unloaded rolling elements. Roller skew and misalignment are neglected, however these effects could be introduced if desired. The descriptions of the lubricant film thickness, traction, and pressure forces is based upon assumptions introduced by Dowson which reduce the complex numerical procedure required for a rigorous solution to the isothermal elastohydrodynamics problem to a set of nonlinear equations. A parametric study on a 1907 basic roller bearing is included to illustrate the use of such a model as a design load.

COLUMNS

72-1290
DYNAMIC STABILITY OF A THIN WALLED COLUMN
Popelar, C.H. (Dept. Engr. Mech., Ohio State Univ., Columbus, Ohio)
ASCE J. Engr. Mech. Div. 98(3), 657-677 (June 1972) 11 refs

Key Words: columns, dynamic stability, flexural vibration, torsional response

The dynamic stability of the free axial vibrations of a preloaded, thin-walled elastic column of open section is investigated. Because of nonlinear coupling of the axial motion with the flexural and torsional motions, the axial motion may become unstable and lead to parametric excitation of flexural or torsional oscillations. A linearized stability theory is used to establish a criterion to predict the excitation of these oscillations. By means of this criterion the relative importance of the flexural and torsional oscillations is evaluated. The effect of the preloading on the regions of stability of the axial motion is also studied.

FRAMES

72-1291
AN APPROXIMATE FORMULA TO CALCULATE THE FUNDAMENTAL PERIOD OF VIBRATION OF STRUCTURAL FRAMES
Arioglu, E. (Executive Committee of Yapi Merkezi, Istanbul, Turkey)
Struct. Engr. 50(3), p 127 (Mar. 1972)

Key Words: natural frequency, seismic excitation, seismic response, structural response

In the behavior of structures under earthquake, the most effective role is played by the fundamental period of vibration of structures because it is one of the main parameters to determine the earthquake forces applied to the structure and it specifies the dynamic stability of the structure. In this paper a simple approximate formula is proposed to calculate the fundamental period of vibration. The calculation with this formula is very short and easy. No mathematical background is necessary to apply the formula. In addition to the derivation and discussion of the formula, several examples showing its application are given.

72-1292
FLOW-INDUCED TRANSVERSE VIBRATIONS OF TRASHBACK BARS
Fortey, J.W. and Tiry, R.F. (Civil Design Branch, Tenn. Valley Authority, Knoxville, Tenn.)
Civ. Engr. (N.Y.) 42(5), 44-45 (May 1972)

Key Words: bars, flexural vibrations

The effects of flow-induced vibrations are important in the design of trashracks subject to high velocity flows. Several instances have been recorded where a jet or plug of high velocity flow has resulted in serious damage to the rack. For large or unusual structures a model study may be necessary to determine the actual flow velocities on which the design must be based. Although much more research is needed to include the effects of the many parameters, it is possible to use the results obtained by Levin to reduce the possibility of transverse vibrations in trashrack bars and other similar elements.

72-1293
NATURAL FREQUENCIES OF MULTISPAN CIRCULAR CURVED FRAMES
Wang, T.M. and Lee, J.M. (Dept. Civil Engr., Univ. N.H., Durham, N.H.)
Intl. J. Solids Struct. 8(6), 791-805 (June 1972) 9 refs

Key Words: frames, natural frequencies

The general dynamic slope-deflection equations for circular curved members of constant section are derived for the determination of natural frequencies of frame structures. An example of a two-span curved frame is given to illustrate the application of the derived equations and to show the effect of the central angle of the arc upon the natural frequencies of the frame.

LINKAGES

72-1294
IMP (INTEGRATED MECHANISMS PROGRAM), A COMPUTER-AIDED DESIGN ANALYSIS SYSTEM FOR MECHANISMS AND LINKAGE
Sheth, P.N. and Uicker, J.J., Jr. (Univ. Wis., Madison, Wis.)
J. Engr. Indus., Trans. ASME 94(2), 454-464 (May 1972) 28 refs

Key Words: matrix methods, mechanisms, network theory

An experimental software system for automating the kinematic, static, and dynamic analyses of arbitrary mechanisms is described. The development of a comprehensive analytical technique based on network theory and matrix methods is summarized. The concept of free generalized coordinates of a mechanism and the importance of automatic identification of these coordinates at each position of the mechanism are explained. The application of the ring data structure concepts of SKETCHPAD to mechanism problems is discussed. The interactive capability of this data structure is then combined with a problem oriented language to develop a general purpose design analysis system. The application of this system to mechanism problems is illustrated by examples of varying complexity.

72-1295

DYNAMIC ANALYSIS OF ELASTIC LINK MECHANISMS BY REDUCTION OF COORDINATES

Winfrey, R.C. (Naval Civil Engr. Lab., Port Hueneme, Calif.)

J. Engr. Indus., Trans. ASME 94(2), 577-582 (May 1972) 13 refs

Key Words: mechanisms

Techniques for the solution of linear matrix differential equations have previously been applied to the dynamic analysis of a mechanism. However, because the mechanism changes geometry as it rotates, a large number of solutions are necessary to predict the mechanism's elastic behavior for even a few revolutions. Also, a designer is frequently concerned with the elastic behavior of only one point on the mechanism and has no practical interest in a complete solution. For these reasons, a method is given for reducing the total number of coordinates to one coordinate at the point of design interest. A considerable saving in computational time is obtained since the dynamic solution involves one degree of freedom instead of many. Further, since any solution makes use of some limiting assumptions, results here indicate that for design purposes reducing the coordinates does not significantly affect comparable accuracy.

MECHANICAL

(Also see Nos. 1207, 1272)

72-1296

DYNAMIC CONTROL OF SPRING-DRIVEN MECHANISMS

Bishop, R.E. and Wilson, C.C. (IBM Office Products Div. Lab., Lexington, Ky.)

IBM J. Res. Develop. 16(3), 222-230 (May 1972) 2 refs

Key Words: deceleration, pneumatic springs, spring-driven mechanisms

A common method for moving a machine member from one position to another is the use of a spring. Spring-driven devices are simple, inexpensive, and easy to implement; however, the velocity characteristics of such devices leave much to be desired. Many methods have been developed for limiting the velocity of spring-driven mechanisms. This paper discusses a method for both velocity control and deceleration by the use of a single pneumatic cylinder. In addition, a method of reducing velocity variability attributable to differences among the work functions of the mechanism is described, and the application of such a device to a paper-cutting mechanism is presented. The concepts and theory presented are general and therefore apply to the entire class of spring-driven mechanisms.

72-1297

TRANSIENT TORSIONAL VIBRATION DUE TO SUDDENLY APPLIED TORQUE

Pollard, E.I. (Elliott Co., Div. of Carrier Corp., Jeannette, Pa.)

J. Engr. Indus., Trans. ASME 94(2), 595-602 (May 1972) 4 refs

Key Words: rotating structures, torsional response, transient response

Several instances of gear, coupling, or turbine-bucket failures in systems in which the compressors were subjected to extensive periods of heavy surge suggested the possibility that the transient torsional vibration caused by the surge could have contributed to the failures which led to this investigation. Calculations of transient torsional vibration during acceleration through resonance and for motor or generator sudden short-circuit are treated in an earlier study. The current paper extends this work to the solution of transient vibration resulting from a

suddenly applied aperiodic torque. The suddenly applied torque can be a step function representing motor or generator trip-out and compressor surge, or any other aperiodic function of exponential form. Transfer functions for shaft torques caused by a sudden change in torque at any point in the system are given for systems with four degrees of freedom. Rules are given for the relatively easy conversion of the transfer functions from the frequency to the time domain. An approximate method of calculating more complex systems is suggested.

72-1298

SELECTING A FLEXIBLE COUPLING FOR A MACHINE-MOTOR UNIT
Polyakov, V.S. and Vilenskii, B.A.
Russ. Engr. J. 51 (9), 23-26 (Engl. Transl. Vestnik Mashinostroeniya (9), 21-, 1971)
2 refs

Key Words: coupled systems, dynamic stiffness, machinery

A method is proposed for selecting (synthesizing) flexible couplings from the magnitude of the dissipative components of the dynamic stiffness at the machine imput shaft, which is either determined experimentally or calculated theoretically.

MEMBRANES

72-1299

VISCOELASTIC BEHAVIOR OF COMPUTER TAPE SUBJECTED TO PERIODIC MOTION
Baumann, G W. (IBM Systems Develop. Div. Lab., Boulder, Colo.)
IBM J. Res. Develop. 16 (3), 214-221 (May 1972) 1 ref

Key Words: computer tapes, moving strips, periodic excitation, viscoelastic properties

The purpose of this study was to develop a theoretical means for predicting the longitudinal motion of computer tape in a high-performance tape drive. In particular, this paper treats the motion that is governed by traveling velocity-stress wave reflections, attenuations, and interactions in the length of tape between the tangency point at the capstan and the tangency point at the stubby column in the drive. The motion of the tape is determined by solving the classical, damped, one-dimensional wave equation subject to the appropriate boundary conditions. J C. Snowdon's low-damping constitutive model is used to describe the viscoelastic behavior of the tape. The solutions for simple boundary conditions are experimentally verified by mechanical impedance techniques. More complex boundary conditions, such as those for vacuum columns, are experimentally studied to determine the true mathematical boundary conditions. Simple unreflected harmonic waves, simple reflected harmonic waves, and general periodic reflected waves are discussed as examples. The significance of the wave interactions in the design of tape drives is considered.

72-1300

A METHOD FOR IMPROVING THE ESTIMATION OF MEMBRANE FREQUENCIES
Torvik, P.J and Eastep, F.E. (Air Force Inst. Tech., Wright-Patterson AFB, Ohio)
J. Sound and Vib. 21 (3), 285-294 (Apr. 8, 1972) 14 refs

Key Words: membranes, natural frequencies

A method for obtaining approximations of the natural frequencies of membranes is developed An approximate expression for the radius of the bounding curve is first written as a truncated Fourier series. The deflection, which is written as a superposition of the modes of the circular membrane, is forced to vanish (approximately) on the approximated boundary. This generates a system of linear homogeneous equations, the unknowns of which are the amplitudes of the modes of the circle. Equating the determinant of coefficients to zero yields an equation from which the approximate frequencies may be found. It is shown that the first-order approximation obtained through this procedure is identical to a method given by Rayleigh. Approximate frequencies of the first several modes of membranes in the shapes of a square, an ellipse, and the limacon of Pascal are then determined as demonstrations of the new second-order approximation. The approximations of the first three natural frequencies of the ellipse are found to be in error by less than 5 percent for eccentricities of 0.8 or less, and the approximations of the first four frequencies of the square are found to be in error by less than 3 percent.

PANELS

72-1301
NONLINEAR PANEL RESPONSE AND NOISE TRANSMISSION FROM A TURBULENT BOUNDARY LAYER BY A MONTE CARLO APPROACH
Vaicaitis, R.; Jan, C.M.; and Shinizuka, M. (Columbia Univ., New York, N.Y.)
AIAA 10th Aerosp. Sci. Meeting, San Diego, Calif. (Jan. 17-19, 1972) AIAA Paper No. 72-199, 9 pp, 12 refs

Key Words: noise transmission, nonlinear response, panels

The vibration of a flexible elastic plate is investigated by a Monte Carlo technique. The response analysis is performed in the time domain by numerically simulating the resulting generalized forces. The nonlinear plate deflection and mutual interaction between the plate motion and external and/or internal air flow is included. The fluid perturbations resulting from the structural motion are described by linear acoustic theory. The boundary layer pressure field is idealized as a homogeneous multidimensional Gaussian random process with mean zero. The differential equations and the boundary conditions are satisfied in the Galerkin sense by developing a modal solution. Numerical examples are presented for subsonic and supersonic flow regions.

PIPES

72-1302
STATIONARY FORCED VIBRATIONS OF MOVING RIGID STRIPS AND OF PIPES WITH LIQUID FLOW
Dresig, K.F.H.
Maschinenbautechnik 21 (3), 110-112 (Mar. 1972) 1 ref

Key Words: flexural vibrations, piping, rods

Transverse vibrations of moving rigid strips and of pipes with liquid flow are described by the same differential equation. Stationary solutions are discovered for forced vibrations. The exact solution is stated with two introduced functions. (In German)

72-1303
HYDRAULIC PRESSURE OSCILLATIONS IN PRESSURE PIPE CONDUITS OF RADIAL HYDRAULIC MACHINES, ESPECIALLY PUMPS
Nechleba, M. (Technische Universität, Brno)
Maschinenbautechnik 21 (3), 113-116 (Mar. 1972) 4 refs

Key Words: harmonic response, machinery, pumps, test models

Relations caused by radial shovel machines are derived. It is shown that model experiments must be carried out with a full pump head, if pulsations like those occurring at large machines are to be obtained. (In German)

72-1304
VIBRATION ANALYSIS OF 3-D PIPING VIA TRANSFER MATRIXES
Rudolf, C.D., III
Naval Postgraduate Sch., Monterey, Calif. (Dec. 1971) 139 pp

Key Words: computer program, natural frequencies, piping

A digital computer program capable of determining the natural frequencies of a three-dimensional piping system having arbitrary configuration is presented. The analysis used the method of transfer matrixes. Piping hangars, loops, and complex branches (branches emanating from branches) are not included. A distributed mass model is used for straight pipe sections, while mass is lumped for curved sections. Inclusion of shear deflection and rotary inertia is optional. Several piping configurations are analyzed using the program. The results are compared with analytical solutions or values from the literature to demonstrate the accuracy and integrity of the program.
AD-738915

72-1305
ON THE ELASTIC BEHAVIOR OF THE PIPE WALL FOR WATER HAMMER APPLICATIONS
Safwat, H.H. (Univ. Tech., Delft, The Netherlands)
Nucl. Engr. Des. 21 (1), 85-94 (1972) 5 refs

Key Words: elastic properties, piping, transient response, water hammer

Strains in the pipe wall during transient conditions resulting from closure of a valve on a horizontal pipline are measured. The strains are used together with transient pressure measurements to evaluate the elastic behavior of the

pipe wall during such hydraulic transient conditions. The assumptions commonly used in the derivation of the continuity equation for water hammer applications are investigated in view of the measurement results.

72-1306

RESPONSE ANALYSIS OF [illegible] SYSTEMS TO MULTI-INPUTS (RESPO[illegible]STIMATION AND ITS FLUCTUATION
Shimizu, N. and Shibata, [illegible] Indus. Sci., Univ. Tokyo, Tokyo, Japan
Bull. JSME 15 (81), 307-315 (Mar. 1972) 11 refs

Key Words: analog computation, dynamic response, nuclear power plants, piping, seismic design

The dynamic response of a piping system to two random inputs is analyzed theoretically and the characteristics of response spectrum of such a system are discussed. The way of superposing its amplification factor from those of single-input models, which were already developed, is discussed. An approximate formula of estimating amplification factor is given based on the modal analysis method for pipings. Experimental studies are done by an analog computer. One hundred modified white noise signals are used as pseudoearthquakes to avoid the effect of sampling or the locality of a particular earthquake. Quantitative discussions of response spectrum of this model are made.

72-1307

ENERGY TRANSMISSION IN PIPING SYSTEMS AND ITS RELATION TO NOISE CONTROL
White, P.H. and Sawley, R.J. (Bolt Beranek and Newman Inc., Los Angeles, Calif.)
J. Engr. Indus., Trans. ASME 94 (2), 746-751 (May 1972) 16 refs

Key Words: fluid-filled containers, noise reduction, piping

The piping in a process plant acts as a distribution and radiation system throughout the plant for many significant sources of noise and vibration such as compressors, pumps, valves and other flow discontinuities, and the like. The acoustical and vibrational energy carried by the piping can result in the establishment of undesirable acoustic fields. This paper looks at those factors which are important to the proper description of the energy interaction and propagation in the fluid-filled piping system and discusses the significance of each in achieving noise control.

PLATES AND SHELLS

(Also see Nos. 1220, 1222, 1223, 1226)

72-1308

ACOUSTIC APPROXIMATIONS IN FLUID-SHELL INTERACTIONS
Bedrosian, B. and DiMaggio, F.L. (Burns and Roe, Oradell, N.J.)
ASCE J. Engr. Mech. Div. 98 (3), 731-742 (June 1972) 7 refs

Key Words: interaction: structure-medium, spherical shells, submerged structures, transient response

A number of approximations for the fluid field are introduced to study the transient response of elastic shells submerged in an acoustic medium. Equivalent approximations to represent the acoustic field are derived for spherical shells and proposed for shells of arbitrary geometry. They are used to obtain the transient response of spherical and spheroidal shells to a suddenly applied uniform pressure and are compared with more exact results.

72-1309

THE DIFFRACTION OF AN UNDERWATER SHOCK WAVE BY A SEMI-INFINITE PLANE
Bijorno, L. (Dept. Fluid Mech., Tech. Univ. Denmark, Lyngby, Denmark)
Acustica 26 (1), 37-42 (Jan. 1972) 12 refs

Key Words: shock waves, underwater explosions

A great number of pressure-time curves measured in shock waves arising from underwater explosions show the existence of a well-defined pressure "shadow and light region", bounded by a strong pressure gradient between the two regions, at the diffraction of the shock waves by a semi-infinite plane situated in the entrance from a channel into a water-filled tank. Through the modification of a method for direct solution of the diffraction problems by pressure waves in air, introduced by Friedlander, the author found that it is possible to extend the method to comprise the calculation of the pressure variation in the wave system which arises by diffraction of weak underwater shocks. Good agreement between the theoretical and experimental values is given.

72-1310

SIMPLIFIED DYNAMICS OF MULTILAYERED ANISOTROPIC VISCOELASTIC PLATES
Biot, M.A. (Brussels, Belgium)
AFOSR-TR-71-0903 (Dec. 1970) 39 pp

Key Words: laminates, plates

Note: For another presentation of this material see Abstract No. 72-929

Procedures are developed for the dynamic analysis of multilayered plates. Analytical simplifications are provided in addition to refinements of the physical description which include the skin effect. The various layers may be anisotropic and each of them may be constituted by thinly laminated materials with stress couples. The damping caused by viscoelasticity is evaluated by a method which brings out the effectiveness of each component material. Detailed end conditions may be imposed at the supports at various points across the thickness. It is shown that a plane strain analysis immediately provides solutions of three-dimensional dynamics for multilayered plates with rectangular, triangular and circular plant forms.
AD-738307

72-1311

PARAMETRIC INSTABILITY OF FLAT PLATES
Dixon, P. and Wright, J. (Royal Air Force, Oakington, England)
Symp. on Nonlinear Dynamics held at Loughborough Univ. Tech., England (Mar. 27-28, 1972) 22 pp, 5 refs

Key Words: experimental results, parametric response, rectangular plates, theoretical analysis

The theoretical and experimental results of an investigation into the parametric instability of flat rectangular plates are presented and discussed. Parametric response (in transverse normal modes of the plate) at approximately half the in-plane forcing frequency, is obtained for several modes of a plate with two clamped and two free edges under direct loading and for the same system under shear loading. Although damping is shown to affect the width and minimum force level of the instability bands determined, these were fairly well predicted by the undamped theoretical bands. The amplitude frequency response curves indicate the pressure of an elastic "hardening" nonlinearity in some modes, which is affected by the freedom of movement of the clamps used to load the plates.

72-1312

A NEW APPROACH FOR PLATE VIBRATIONS: COMBINATION OF TRANSFER MATRIX AND FINITE ELEMENT TECHNIQUE
Dokainish, M.A. (McMaster Univ., Hamilton, Ontario, Canada)
J. Engr. Indus., Trans. ASME 94(2), 526-530 (May 1972) 9 refs

Key Words: finite element technique, plates, shells, transfer matrix method

When the finite element method is used in the vibration analysis of plates and shells, it results in large matrixes requiring a large digital computer. A commonly used method of reducing the matrix size is to eliminate certain "slave" displacements by minimizing strain energy. The approach requires good judgement in the selection of the "master" displacements and involves additional approximations and some loss of accuracy. In the present method small matrixes are obtained without any further approximations and without reducing the number of degrees of freedom. The transfer matrix technique, generally known as the Holzer-Myklestad method, is well known for beams and shafts. The present method is an extension of this idea to plates.

72-1313

THE RESONANT RESPONSE OF A RECTANGULAR PLATE WITH AN ELASTIC EDGE RESTRAINT
Egle, D.M. (Univ. Okla., Norman, Okla.)
J. Engr. Indus., Trans. ASME 94(2), 517-525 (May 1972) 24 refs

Key Words: rectangular plates, resonance

An analysis of a plate, simply supported on three edges and elastically restrained on the fourth, excited by a concentrated load with a harmonic time history, is used to study the peak resonant response of the plate for several configurations and a wide range of edge restraint. Classical thin plate theory is employed with a complete elastic modulus to account for energy dissipation. An approximate method, based on a single term normal mode solution, is developed for calculating the limits of the peak resonant response for arbitrary edge restraint.

72-1314

ELASTOPLASTIC DYNAMICAL BUCKLING OF CIRCULAR THIN SHELLS UNDER AXIAL IMPACT

Eringen, A. C. and Chang, T. (Gen. Tech. Corp., Lawrenceville, N.J.)

TR-13-2 (Dec. 1970) 43 pp

Key Words: circular shells, dynamic buckling

Dynamical motions of a circular cylindrical thin shell simply supported at one end and free to expand in the circumferential and radial direction at the other end are studied under the condition of axial impact. The axial compressions applied exceed the static buckling loads. As the initial conditions, the displacement field and velocity field of circumferential and radial directions are assumed to vanish, except for the initial axial velocity field of the cylinder. In order to account for the effect of plasticity (without unloading) on buckling, the second order elastic stress-strain relations are used with simplifications that the effect of the initial axial load on the bending moment is constant. The displacement and stress fields are obtained by solving the dynamical equations of motions under the boundary and initial conditions. The shortening of the shell at any time and the classical static buckling, including the plastic effect, are determined.

AD-731297

72-1315

SCATTERING OF A TRANSIENT ACOUSTIC WAVE BY AN ELASTIC CYLINDRICAL SHELL

Geers, T. L. (Lockheed Missiles and Space Co., Palo Alto, Calif.)

J. Acoust. Soc. Amer. 51 (5), 1640-1651 (May 1972) 34 refs

Key Words: acoustic scattering, cavities, cylinders, cylindrical shells, submerged structures

A plane acoustic step wave traveling through an infinite fluid medium is scattered by an infinite, elastic, circular cylindrical shell whose axis is parallel to the wave front of the incident wave. The resulting transient acoustic field is studied through the use of temporal convolution techniques in conjunction with wave front analysis. Computed pressure histories are presented for various points in the fluid. The field produced by the cylindrical shell is compared with those produced by a fixed rigid cylinder and a cylindrical cavity. Attention is given to the nearfield pressure reduction capability of the cavity.

72-1316

ACOUSTIC REDUCTION OF AN INTERNALLY EXCITED CLOSED CYLINDRICAL SHELL

Gel'fgat, V.I.; Guzhas, D.R.; Mikhailov, R.N.; and Tartakovskii, B.D. (Acoustics Inst., Acad. Sci. USSR, Moscow, USSR)

Sov. Phys., Acoust. 17 (4), 464-467 (Apr./June 1972) (Engl. Transl. Akust. Zh. 17 (4), 545-549 (Oct./Dec. 1971) 6 refs

Key Words: cylindrical shell, sound waves

The acoustic reduction of a cylindrical shell under internal axisymmetric excitation and for a normal mode propagating inside the shell is investigated. It is shown that the acoustic reduction of the shell at low frequencies greatly exceeds the acoustic reduction of a plate having the same thickness. The acoustic reduction decreases as the frequency is increased, coinciding with the acoustic reduction of the equivalent plate at high frequencies. The results have been tested experimentally, with good agreement between the analytical and experimental data.

72-1317

THEORY OF VIBRATION OF INITIALLY STRESSED SHELLS

Kalnins, A. and Biricikoglu, V. (Dept. Mech. Engr. and Mech., Lehigh Univ., Bethlehem, Pa.)

J. Acoust. Soc. Amer. 51 (5), 1697-1704 (May 1972) 12 refs

Key Words: shells, vibration response

Governing equations are derived for an initially stressed shell undergoing an infinitesimal elastic process in which transverse shear and normal strains are accounted for. The point of view is adopted that this process begins with the initially stressed state for which geometry, state of stress, and material properties are known. The equations represent an exact two-dimensional counterpart of the corresponding equations for an initially stressed three-dimensional medium. The only approximation introduced is that of a linear displacement field in the transverse direction. The equations contain all initial stress terms, and they can be applied to determine the effect of the initial stresses in all types of modes of free vibration of a shell.

72-1318

EXACT RESONANT FREQUENCIES FOR THE THICKNESS-TWIST TRAPPED ENERGY MODE IN A PIEZOCERAMIC PLATE

Keuning, D.H. (Dept. Math., Univ. Groningen, P.O. Box 800, Groningen, The Netherlands)

J. Engr. Math. 6(2), 143-154 (Apr. 1972) 5 refs

Key Words: Fourier transformations, natural frequencies, piezoelectric materials, plates

Thickness-twist modes with energy trapping in a piezoceramic plate covered by infinite strip electrodes of infinitesimal thickness are analyzed. By using Fourier transforms, the linear, three-dimensional equations for a piezoceramic plate are reduced to an integral equation for the charge distribution on the electrodes. Expanding the charge density in a finite series, the author computes the lowest resonant frequency as a function of the ratio with electrodes over the thickness plate. The computed values are compared with the results of an approximate approach given by Holland and Ter Nisse. For small values of the mentioned ratio, considerable deviations occur.

72-1319

RADIATION OF SOUND BY INTERACTING ELASTIC SHELLS

Klyachkin, V.I. and Usoskin, G.I.

Sov. Phys., Acoust. 17(4), 486-491 (Apr./June 1972) (Engl. Transl. Akust. Zh. 17(4), 574-581 (Oct./Dec. 1971) 5 refs

Key Words: coupled systems, shells, sound waves

The oscillations and acoustic radiation of arbitrary shells forming a coupled system as a result of their interaction through the ambient medium are analyzed. The system of integro-differential equations to which the problem is reduced is solved in general form with the aid of a set of auxiliary Green functions for the oscillations of the shells. The expression for the radiation field of the interacting shells is represented in quadrature form involving the Green functions of the Helmholtz equation and equations for the shell oscillations. The general expressions are specialized for the cases of one and two shells.

72-1320

RESPONSE OF THIN CONICAL SHELLS TO DYNAMICALLY APPLIED AXIAL FORCE

Nash, W.A. and Wilder, J.A. (Univ. Mass., Amherst, Mass.)

Intl. J. Nonlinear Mech. 7(1), 65-80 (Feb. 1972) 8 refs

Key Words: conical shells, dynamic buckling

The response of an elastic truncated conical shell to a dynamically applied axial force is investigated by means of nonlinear equations governing the finite deformations of the shell. Initial imperfections of the shell are considered. Numerical solutions to the governing equations indicate that the magnitude of the buckling load and the number of longitudinal waves increases for increased rates of loading.

72-1321

NONLINEAR VIBRATIONS OF CIRCULAR CYLINDRICAL SHELLS WITH VARIOUS BOUNDARY CONDITIONS

Nataraja, R. and Johns, D. J. (Loughborough Univ. Tech., Loughborough, England)

Symp. on Nonlinear Dynamics held at Loughborough Univ. Tech , England (Mar. 27-28, 1972) 14 refs

Key Words: cylindrical shells, nonlinear response

A generalized formulation for the nonlinear vibration analysis of thin circular cylindrical shells is developed for any boundary condition and arbitrary loading. Flugge's shell theory modified to include large deformation effects is used. The effect of rotary and in-plane inertias is also included. The theory is extended to include structural damping and response and phase plots for the damped vibrations are studied.

72-1322

CONDITIONS FOR THE EXISTENCE OF DYNAMIC SNAP-THROUGH OF A SHALLOW CYLINDRICAL SHELL UNDER IMPULSIVE LOADING

Ovenshire, J.J. and McIvor, I.K. (Natl. Highway Safety Bur., Washington, D.C.)

Intl. J. Nonlinear Mech. 7(1), 19-29 (Feb. 1972) 4 refs

Key Words: cylindrical shells, snap-through problems

Shallow shell theory is used to investigate the nonlinear plane deformation of a circular cylindrical panel elastically restrained against rotation at the supports. The critical or equilibrium configurations which may exist at zero load are determined. By examining the local stability of the various configurations, the authors obtain the critical rotational stiffness above which the shell cannot exhibit dynamic snap-through under impulsive load. Finally for the range of geometries and rotational stiffness for which snap-through may exist, a sufficient condition for stability is given.

72-1323

SOUND RADIATION INTO A LIQUID LAYER FROM A PLATE DRIVEN BY A POINT FORCE
Romanov, V.N.
Sov. Phys., Acoust. 17(4), 505-509 (Apr./June 1972) (Engl. Transl. Akust. Zh. 17(4), 599-604 (Oct./Dec. 1971) 3 refs

Key Words: flexural vibration, plates, sound waves

The sound field is analyzed in a liquid layer bounded on one side by a half-space having a specified aoustic impedance and on the other by a flexurally vibrating plate in contact with a liquid half-space. It is shown that the sound pressure in the liquid layer has a complex spatial distribution, but the latter can be described by simple relations at low frequencies. The effect of the impedance of the surface of the half-space on the field inside the layer is analyzed.

72-1324

DYNAMIC RESPONSE OF ELASTICALLY SUPPORTED CIRCULAR PLATES TO A GENERAL SURFACE LOAD
Schlack, A. L., Jr.; Kessel, P.G.; and Dong, W.N. (Univ. Wis., Madison, Wis.)
AIAA J. 10(6), 733-738 (June 1972) 9 refs

Key Words: circular plates, dynamic response, elastic foundation

An analytical study is presented for the general dynamic response of elastically supported circular plates with an initial tension subjected to an arbitrary surface load $p(r,\theta,t)$. The plates are considered to be supported by a Winkler elastic foundation and elastically constrained against rotation at the outer edge. General natural frequency equations are presented with numerical values included for the first four modes of vibration plotted as functions of initial tension and elastic edge constraints ranging from clamped to simply supported edges. The general solution for forced response is given in an integral form based on Fourier-Bessel techniques with several useful examples included. Static buckling loads are also included for a range of limiting cases.

72-1325

EXTENSIONAL VIBRATIONS OF PIEZOELECTRIC PLATES
Schmidt, G.H. (Dept. Math., Univ. Groningen, Groningen, The Netherlands)
J. Engr. Math. 6(2), 133-142 (Apr. 1972) 7 refs

Key Words: circular plates, lateral vibrations, natural frequencies, piezoelectric materials

We consider piezoelectric plates with a thickness small with respect to the lateral dimensions. The surfaces of these plates are partly coated with electrodes. Equations are derived which describe the lateral vibrations of these plates approximately. The first resonance-frequency of a circular plate as a function of the radius of the electrodes is computed and compared with measured values.

72-1326

NATURAL FREQUENCIES OF CLAMPED-FREE CIRCULAR CYLINDRICAL SHELLS
Sharma, C.B. and Jones, D.J. (Univ. Manchester, Inst. Sci. and Tech., Manchester, England)
J. Sound and Vib. 21(3), 317-327 (Apr. 8, 1972) 4 refs

Key Words: cylindrical shells, natural frequencies

Some experimental studies of the circumferential mode vibration characteristics of clamped-free circular cylindrical shells are reported and the results compared with some available theoretical predictions. Good agreement has been obtained for the natural frequencies for configurations typical of unstiffened steel stacks. Measurements of structural damping for aluminum and steel shells have shown that this is not a function of mode shape and is nearly the same for both materials.

72-1327

ON THE GOVERNING EQUATIONS FOR A LAMINATED PLATE
Sun, C.T. and Cheng, N.C. (Purdue Univ., Lafayette, Ind.)
J. Sound and Vib. 21(3), 307-316 (Apr. 8, 1972) 8 refs

Key Words: laminates, natural frequencies, plates

A set of plate equations for a laminated plate is derived. It is assumed that the normal stress vanishes through the thickness of the plate. The shear and geometric correction coefficients are introduced to compensate the errors induced by the approximate plate displacement and the averaging process. Microstructure is present in the model. Harmonic wave propagation is investigated and solutions are compared with the exact solutions. Excellent agreement is found. Natural vibrations of a rectangular laminated plate are discussed and numerical results are presented.

RINGS

72-1328
ACOUSTIC RADIATION IMPEDANCE OF CAPS AND RINGS ON OBLATE SPHEROIDAL BAFFLES
Baier, R. V. (Naval Res. Lab., Washington, D.C.)
J. Acoust. Soc. Amer. 51(5), 1705-1716 (May 1972) 15 refs

Key Words: caps, rings, sound waves, vibrating structures

The acoustic radiation impedance of curved vibrating caps and rings located on hard baffles of oblate spheroidal shape is analyzed using eigenfunction expansion in oblate spheroidal wave functions. The numerical evaluation of the formulas is accomplished with the help of extensive computer programs. The results are presented in families of plotted curves showing the effect of curvature on the acoustic radiation impedance. Calculations are made for values of the acoustic size in the range $0.1 \leq ka \leq 20.0$.

72-1329
AN EXPERIMENTAL METHOD FOR IMPULSIVELY LOADING RING STRUCTURES
Walling, H.C.; Forrestal, M.J.; and Tucker, W.K. (Sandia Corp., Sandia Labs., Albuquerque, N. Mex.)
Intl. J. Solids Struct. 8(6), 825-831 (June 1972) 18 refs

Key Words: impact tests, rings, testing techniques

An experimental method for impulsively loading structural rings with a simultaneously applied, short duration pressure pulse is presented. The loading is produced by magnetic pressure between two parallel current carrying conductors. A fast discharge capacitor bank and a current pulse shaping technique are utilized to provide a pressure pulse with a duration of about 2 μsec, which is sufficiently short so that loading can be considered impulsive for most structural ring experiments. Applicability of the method is demonstrated with an experiment where the impulse is cosinusoidally distributed over half the circumference of a thin aluminum ring. Measured strain-time histories are in close agreement with theoretical predictions.

SPRINGS
(Also see No. 1296)

72-1330
DESIGNING DISK SPRING SYSTEMS
Gekker, F.R.
Russ. Engr. J. 51(9), 16-17 (1971) (Engl. Transl. Vestnik Mashinostroeniya (9), 16-, 1971) 3 refs

Key Words: disk springs, springs

The influence of the radius of curvature of toroidal projections on the thrust rings on the stiffness characteristics of devices incorporating disk springs is investigated.

STRUCTURAL

72-1331
VERTICAL VIBRATION OF A RIGID CIRCULAR BODY AND HARMONIC ROCKING OF A RIGID RECTANGULAR BODY ON AN ELASTIC STRATUM
Awojobi, A.O. (Dept. Mech. Engr., Univ. Lagos, Lagos, Nigeria)
Intl. J. Solids Struct. 8(6), 759-774 (June 1972) 11 refs

Key Words: cylinders, vibration

The mixed boundary-value problems of the vertical vibration of a rigid circular body and the rocking of a long rigid rectangular body on the infinitely wide elastic stratum are precisely formulated in terms of dual integral equations. Approximate solutions for the case of a frictionless foundation base are obtained by establishing an equivalent system on a semi-infinite elastic medium. It is shown that the response of a body vibrating at frequency factor η_2 on a stratum of finite depth is approximately equivalent to that of the body with its inertia increased by a factor η_2^2/η_{2e}^2 but vibrating at a lower frequency factor $\eta_{2e} = (\eta_2^2 - 1/h^2)^{\frac{1}{2}}$ on a semi-infinite medium of the same elastic constants as the stratum of nondimensional depth h. All the results approach corresponding semi-infinite medium results as the stratum depth tends to infinity. Important results established are: a stratum depth of about five times the base radius (or semiwidth, for the rectangular body) is a fair approximation to a semi-infinite medium; resonant frequency of a body on a stratum decreases with increasing stratum depth; and the resonant frequency factor, η_2, of bodies with

large inertia ratios (greater and about 10) can be estimated from the semi-infinite medium solution irrespective of the stratum depth. The present theory consistently shows good agreement with the experimental results of Arnold et al.

72-1332

NATURAL FREQUENCY DETERMINATION OF LONG SPAN FLOOR SLABS
Chadha, J. and Allen, D.L. (Hydro Electric Power Comm. of Ontario, Toronto, Canada)
J. Engr Indus., Trans. ASME 94(2), 660-664 (May 1972) 10 refs

Key Words: floors, natural frequency, rectangular plates

This paper presents a general procedure for calculating the natural frequencies of rectangular plate structures which have beam stiffeners in the interior and at the boundaries. The technique of analysis accounts for shear deflections and rotary inertia of the plate. The effect of torsional and flexural reactions of the supporting beams on the plate-beam structure is included. The natural frequencies are compared with experimental values and also with those obtained by orthotropic plate approximation and Rayleigh's method.

72-1333

VIBRATIONS OF A HOLLOW PIEZOELECTRIC CERAMIC SPHERE
Lazutkin, V.N.
Sov. Phys., Acoust. 17(4), 496-499 (Apr./June 1972) (Engl. Transl. Akust. Zh. 17(4), 588-592 (Oct./Dec. 1971) 5 refs

Key Words: piezoelectric materials, spherical shells

A solution of the dynamical problem is given for a piezoelectric ceramic resonator in the form of a hollow sphere with radial polarization. The frequency equation is given, along with the displacement distribution laws at the radial-mode resonances, including "peripheral" and "thickness" resonance. By taking into account the influence of the piezoelectric effect on the elastic constants and anisotropy of the material it is possible to extend the results of the analysis to present-day piezoelectric ceramics.

72-1334

LARGE AMPLITUDE, FREE VIBRATION OF GEOMETRICALLY NONLINEAR CIRCULAR ARCHES
Sabir, A.B. and Lock, A.C. (Univ. Col., Cardiff, Wales)
Symp. on Nonlinear Dynamics held at Loughborough Univ. Tech., England (Mar. 27-28, 1972) 21 pp, 14 refs

Key Words: arches, free vibration, numerical analysis

The complex relationships between frequency and large amplitude of freely vibrating shallow circular arches are obtained. A finite element method incorporating a new shape function for circular arches is used to obtain the nonlinear and linearized incremental stiffness matrixes A numerical method, derived directly from the basic differential equation of motion and expressed in the form of a recurrence-matrix of finite differences is used to obtain the variation of amplitude with time The amplitude-frequency relationship for an intially flat beam is also determined and found to agree well with that obtained by other authors. All the numerical results are obtained for an initial transverse displacement of the arch in the form of a sine wave directed away from its center of curvature and the corresponding initial circumferential displacement is calculated by assuming that the thrust in the arch is constant.

SYSTEMS

ABSORBER

72-1335

RANDOM VIBRATION WITH NONLINEAR DAMPING
Kirk, C.L. (Struct. and Aerosp. Dynamics Group, Cranfield Inst. Tech., Cranfield, Bedford, England)
Symp. on Nonlinear Dynamics held at Loughborough Univ. Tech., England) (Mar. 27-28, 1972) 18 pp, 6 refs

Key Words: aircraft, random response, runway roughness, vibration dampers

This paper consists of three parts. The first is a theoretical study of a random vibration absorber in which the damping force is proportional to the square of the relative velocity between the main mass and the absorber mass of the system. The optimum damping constant

and the ratio (natural frequency of main mass/ natural frequency of absorber mass) required to minimize the main mass root mean square response is determined. In the second part, the random vibration during taxiing of a two degree-of-freedom model of an aircraft on its main undercarriage, because of runway unevenness, is considered. The optimum damping coefficient is determined which minimizes the root mean square response of the center of gravity. An experimental investigation of the random vibration of a built-up beam having hysteretic damping is considered in the third part. It is shown that when the exciting force has a Gaussian distribution, nonlinear damping produces a response in which the distribution is non-Gaussian.

72-1336
INCREASE IN SHOCK ABSORBER TEMPERATURE AND DAMPING EFFECT
Mitschke, M. and Riesenberg, K.-O.
(T.H. Braunschweig, Braunschweig, Germany)
Automobiltech. Z. 74 (4), 133-139
(Apr. 1972) 9 refs

Key Words: shock absorbers, viscous damping

The temperature of oil used on shock absorbers affects riding properties to the extent that temperature changes viscosity. The relationship between speed, road roughness, heat transfer, flow conditions around the absorbers, and outside shock absorber temperatures is demonstrated experimentally and theoretically. An explanation is given for the increased damping effect in winter on good streets at low speeds. (In German)

72-1337
ELASTOMERIC ENERGY ABSORBER
Nordlin, E.F. and Stoker, J.R.
Calif. State Div. Highways, Materials and Res. Dept., M/R 656592 (Nov. 1971) 21 pp

Key Words: bridges, elastomers, energy absorption, seismic design, test data

The report covers testing performed on a proposed elastomeric energy absorbing and restraining unit designed to restrict movement at the hinge openings of reinforced concrete bridge spans when subjected to earthquake forces. Minor modifications were made for each of five tests conducted on a thick walled neoprene tubing contained in extra heavy steel pipe. Load deflection tests of the restrained neoprene determined the final amount of movement for the forces involved. The results are reported.
PB-207838

ACOUSTIC ISOLATION
(Also see No. 1375)

72-1338
ANALYSIS, TESTING, AND DESIGN OF LINED DUCTS
Wirt, L.S. (Lockheed-California Co., P.O. Box 551, Burbank, Calif.)
J. Acoust. Soc. Amer. 51 (5), 1448-1463
(May 1972) 10 refs

Key Words: acoustic linings, ducts

Note: For another presentation of this material see Abstract No. 72-118.

Lined ducts containing flow and intense sound have been extensively studied in recent years. Parametric studies have revealed so many variables that design procedures are obscured. Analysis by solution of the convected wave equation has been complicated by uncertainties about the actual modal distribution and by uncertainties about the actual boundary impedance. As a result, when discrepancies occur between experimental and analytical results it is difficult to interpret whether the wave-equation solution, the modal assumption, the impedance value, or the test procedure is deficient. The simultaneous refinement of all four factors has resulted in a very satisfactory correlation between theory and duct test results which provides a basis for lucid duct design procedures and the evolution of new liner materials. A duct test facility has been built which appears to provide equipartition of energy. The impedance of nonlinear materials has been redefined and measurement methods modified. Contours of equal duct attenuation in the impedance plane have been generated and prove to be simple in shape. From these, a design methodology is deduced which may be applied to any liner material and which eliminates many redundant parameters.

72-1339
BEHAVIOR OF NOZZLES AND ACOUSTICS LINERS IN THREE-DIMENSIONAL ACOUSTIC FIELDS
Zinn, B.T.; Daniel, B.R.; and Smith, A.J., Jr.
Georgia Inst. Tech., Atlanta, Ga.
NASA-CR-121070 (Nov. 1971) 41 pp

Key Words: acoustic linings, nozzles

Theoretical values of the admittances of various nozzles are computed and compared with corresponding experimental values. The existing data reduction scheme was corrected and all available experimental data has been rechecked and

corrected whenever necessary; the updated experimental admittance values are presented. An analysis associated with the frequency sensitivity of experimental admittance values was initiated and the analog-to-digital Data Reduction Program which has become operational is discussed. Fourteen nozzle tests were conducted during this report period.
N72-14703

AIRCRAFT

(Also see Nos. 1243, 1244, 1276, 1335, 1338, 1352, 1361)

72-1340

INVESTIGATION OF AIRCRAFT TIRE DAMAGE RESULTING FROM TOUCHDOWN ON GROOVED RUNWAY SURFACES
Byrdsong, T.A.; McCarty, J.L.; and Yager, T.J.
Natl. Aeronaut. and Space Admin., Langley Res. Ctr., Langley Station, Va.
NASA-TN-D-6690 (Mar. 1972) 21 pp

Key Words: aircraft tires, landing impact, tires

Simulated landing impact tests conducted to study chevron-cutting damage to the tread of aircraft tires resulting from touchdown on grooved runway surfaces are reported. The study, involved impacting new and retreaded tires at several inflation pressures, vertical loadings, and sink rates on concrete and asphalt surfaces having a variety of transversely grooved patterns at ground speeds up to approx 110 knots. Chevron cutting occurs at the spot on the tire which initially contacts the surface and the damage is the result of the scrubbing action of the tire as it skids over the grooves prior to rotation. The extent of chevron cutting is found to be primarily a function of the airplane ground speed at touchdown; the higher the speed, the greater the damage. Chevron-cutting damage is essentially independent of the grooving patterns generally considered for airport use but is dependent upon the nature of the surface finish. Tests with dif.erent tires of the same size also indicate that the tread rubber compounding significantly affects the extent of chevron cutting damage.
N72-17007

72-1341

THE INFLUENCE OF NONLINEAR LONGITUDINAL AERODYNAMIC CHARACTERISTICS ON THE POWER SPECTRAL RESPONSE OF AIRCRAFT TO ATMOSPHERIC TURBULENCE
Christopher, P.A.T. and Dunn, J.M.H. (Cranfield Inst. Tech., England)
Symp. on Nonlinear Dynamics held at Loughborough Univ. Tech., England) (Mary. 27-28, 1972) 16 pp, 8 refs

Key Words: aerodynamic characteristics, aircraft, power spectral technique, turbulence

The power spectral technique is extended to show the effect of aerodynamic nonlinearities on the normal acceleration response of a rigid aircraft in the cruise configuration. Extreme nonlinearities in the normal force and pitching moment variations with incidence are considered. The resulting changes from the linear root mean square values of normal acceleration are only 3 to 5-1/2 percent.

72-1342

CONCORDE DYNAMICS -- A REVIEW
Hitch, H. (Brit. Aircraft Corp., Ltd., Weybridge, Surrey, England)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-381, 4 pp

Key Words: aircraft, dynamic properties

The flight testing and development of Concorde is well under way and the dynamic behavior in flight is emerging. The paper reviews briefly the experiences to date and makes some comparisons with prediction. Some thoughts on dynamic problems in general are presented.

72-1343

EFFECTIVE AXIAL SOURCE DISTRIBUTIONS IN A CHOKED SCREECH JET
Lee, B.H.K. and Westley, R. (Natl. Aeronaut. Establishment, Natl. Res. Council, Ottawa, Ontario, Canada)
AIAA 10th Aerosp. Sci. Meeting, San Diego, Calif. (Jan. 17-19, 1972) AIAA Paper No. 72-159, 7 pp, 17 refs

Key Words: aircraft, noise

A jet containing shock cells may emit axisymmetric sound waves of high intensity and discrete frequency. The number, axial positions, strengths and phases of the effective sound sources within such a jet are computed by a

minimization technique using experimental measurements of the sound pressure along a line in the nearfield. This derived source information could shed new light on the mechanism by which shock cells produce screech noise. Eddy convection Mach numbers are computed and compared with schlieren photographs of the motion of wave disturbances within the jet. The method enables complicated nearfields of screech noise to be computed from limited experimental data.

72-1344

SOME MEASURED AND CALCULATED EFFECTS OF RUNWAY UNEVENNESS ON A SUPERSONIC TRANSPORT AIRCRAFT
Mitchell, C.G.B. (Road Res. Lab., Transport Res. Assessment Group)
Symp. on Nonlinear Dynamics held at Loughborough Univ. Tech., England (Mar. 27-28, 1972) 16 pp, 9 refs

Key Words: aircraft, runway roughness, vibration response

Theoretical analyses and test experience with Concorde show that the SST is more sensitive to uneven runways than is the subsonic transport. Care must be taken to minimize undercarriage stiffness and friction if problems of cockpit vibration and airframe and undercarriage fatigue are to be avoided.

BRIDGES

72-1345

AN EVALUATION OF BRIDGE VIBRATION AS RELATED TO BRIDGE DECK PERFORMANCE
Goodpasture, D.W. and Goodwin, W.A.
Tenn. Univ., Dept. of Civil Engr., Knoxville, Tenn. (Dec. 1971) 127 pp

Key Words: bridges, vibration response

An investigation of concrete bridge deck deterioration is reported. Three aspects of concrete bridge deck construction and behavior as related to deterioration are examined. Five bridges were observed under construction with certain measurements being made including the thickness of the deck, cover over reinforcing bars, temperature, humidity and wind velocity. Six were observed while subject to normal traffic for a period of 7 months. The study covered a 3 year period.
PB-207222

72-1346

ON THE TRANSVERSE FREE VIBRATIONS OF BEAM-SLAB TYPE HIGHWAY BRIDGES
Ng, S. F. and Kulkarni, G.G. (Dept. Civil Engr., Univ. Ottawa, Ottawa, Canada)
J. Sound and Vib. 21(3), 249-261 (Apr 8, 1972) 9 refs

Key Words: bridges, natural frequencies

Analysis of vibration problems dealing with plate eigenfunctions and transcendental equations involves rather tedious trial and error solutions to trigonometric and hyperbolic functions. A modified approach based on the orthotropic plate theory for computing the natural frequencies of bridge slabs is presented through a set of empirical relationships between the plate parameters. A general outline of the analytical procedure and computed values of natural frequencies of vibration of such slabs for a wide range of parameters are given. Whenever possible, results from the present investigation are compared with those obtained by other methods; good agreements are obtained.

72-1347

SEISMIC RESPONSE PREDICTIONS OF BRIDGE PIER
Shepherd, R. and McConnel, R.E. (Civil Engr., Univ. Auckland, New Zealand)
ASCE J. Engr. Mech. Div 98(3), 609-627 (June 1972) 12 refs

Key Words: bridges, plastic deformation, seismic response

It is generally accepted that if a structure is to withstand high intensity earthquakes some plastic action must take place somewhere in the structure. Initial considerations of a proposed reinforced concrete railway viaduct indicate that under lateral load, only essentially axial forces are induced in the pier legs, and it is well known that axially loaded concrete is capable of relatively little plastic action. If the inverted V-frame configuration is to be used in a seismically active region, such as the center of the North Island of New Zealand, design engineers suggest that steel pins be placed in the pier legs, near their base, to allow plastic deformation in the legs and thus induce plastic response in the pier. The results of studying the feasibility of this idea are described. In particular the possibility is examined of choosing pins of such a diameter that they may yield axially under strong motion earthquakes and thereby remove sufficient energy from the structures to protect it, without unacceptable plastic deformations occurring.

BUILDING

72-1348

HIGHRISE BUILDING CHARACTERISTICS AND RESPONSES DETERMINED FROM NUCLEAR SEISMOLOGY

Blume, J.A (John A. Blume & Assoc. Res. Div., Sheraton-Palace Hotel, 100 Jessie St., San Francisco, Calif.)

Bull. Seismol. Soc. Amer. 62 (2), 519-540 (Apr. 1972) 8 refs

Key Words: buildings, nuclear explosions, seismic response, underground explosions

Reliable measurements and detailed analyses of the responses of many buildings to ground motion resulting from underground nuclear explosions are providing new and valuable information on the structural-dynamic properties and behavior of real buildings. Much of this knowledge is applicable to the problem of resisting natural earthquake ground motion, and is being obtained as a byproduct of the AEC underground explosive nuclear safety program. Information is provided on oscillator spectral response values, building responses, modal contributions and combinations vs elapsed time and at times of maximum response, variations in natural periods, foundation material interaction, and biaxial motion in the horizontal plane. Data are shown for nuclear events JORUM and HANDLEY and they compared to those of prior major events. In addition, peak responses of certain Las Vegas buildings to the distant February 1971 San Fernando earthquake (U.S. Geological Survey, 1971) are provided and compared to responses to nuclear events.

72-1349

SPECTRAL TREATMENT OF ACTIONS OF THREE EARTHQUAKE COMPONENTS ON STRUCTURES

Chu, S.L.; Amin, M.; and Singh, S. (Sargent and Lundy Engineers, Chicago, Ill.)

Nucl Engr. Des. 21 (1), 126-136 (1972) 3 refs

Key Words: nuclear reactors, seismic response

A discussion is given of a precedure for applying response spectrum techniques to estimate the simultaneous actions of three earthquake components on the same response in an arbitrary elastic structure. The procedure is applied to the analysis of a nuclear reactor facility and the results are checked with those obtained from a complete time-history analysis of the system.

72-1350

MODAL COUPLING AND EARTHQUAKE RESPONSE OF TALL BUILDINGS

Hoerner, J.B.
Calif Inst. Tech., Earthquake Engr. Res. Lab., Pasadena, Calif.

EERL-71-07 (May 1971) 163 pp

Key Words: buildings, multistory buildings, seismic design

The major dynamic features of tall buildings are examined with a shear beam model. The usual one-dimensional model is extended to three dimensions to include modes with translational and rotational components. A class of linear response models for tall buildings is presented having three sets of mutually orthogonal coupled modes. The amount of modal coupling is related to the eccentricities and frequency differences. A perturbation scheme is developed for buildings almost in this class. Rotational components of earthquake response in buildings are related to modal coupling.

PB-207635

HELICOPTORS

(Also see No. 1392)

72-1351

EFFECT OF LEADING-EDGE SERRATIONS ON NOISE RADIATION FROM A MODEL ROTOR

Arndt, R.E.A. and Nagel, R.T.
The Pa. State Univ., University Park, Pa.

AIAA Paper No. 72-655

Key Words: aerodynamic characteristics, noise reduction, rotors

The possibility of using leading-edge serrations for rotor noise reduction is examined experimentally. Consideration is given to both the acoustic and aerodynamic characteristics of rotors with and without leading-edge devices. Measurements of total radiated power, directivity and nearfield sound pressure level indicate that reduction in noise is possible with specific leading-edge configurations and running conditions. Both vortex noise and rotational noise is attenuated. Hot wire and flow visualization studies indicate that the reduction in vortex noise is associated with changes in the vortex shedding characteristics. Reductions in rotational noise are correlated with thrust and torque data.

72-1352

FLUCTUATING LIFT FORCES OF VON KARMAN VORTEX SHEDDING ON SINGLE CIRCULAR CYLINDERS AND IN TUBE BUNDLES -- PART 3: LIFT FORCES IN TUBE BUNDLES

Chen, Y.N. (Res. Lab. for Vib. and Acoustics, Sulzer Bros. Ltd., Winterthur, Switzerland)

J. Engr. Indus., Trans. ASME 94 (2), 623-628 (May 1972) 8 refs

Key Words: coupled response, tubes, vortex shedding

The trend of the fluctuating life coefficient C_L and the dimensionless shedding frequency S (Strouhal number) of the vortex in tube bundles at higher Reynolds numbers R is predicted by the course of the steady pressure drag coefficient C_D at the corresponding R ranges. Furthermore, some measurements of the vortex lift forces in tube bundles are given. It reveals that the lift force for certain small transverse tube spacings possesses a strong second harmonic. The tubes and, therefore, the transverse gas column in the tube bundle channel can be excited to vibrate in resonance either at the critical flow velocity or at its half value. The coupled vibration between the vortex shedding and the transverse gas column is considered with some experiments.

HUMAN

72-1353

MECHANICAL IMPEDANCE AND ITS VARIATION IN THE RESTRAINED PRIMATE DURING PROLONGED VIBRATION

Broderson, A.B. and Von Gierke, H.E. (Aerosp. Med. Res. Lab., Wright-Patterson AFB, Ohio)

ASME Paper No. 71-WA/BHF-8

Key Words: animal response, vibration excitation

Biomechanical parameters of the sitting primate and their temporal changes during sinusoidal vibration (6-30 Hz) are investigated. Impedance and phase angle decrease with time. While resonances occur initially at several frequencies, response changes significantly within 10 min and only one resonance remains after 1 hr. High-frequency impedance response is masslike. The authors derive a simple model of impedance response and discuss implications for future biomechanical and physiological modeling in view of high-frequency mass characteristic and temporal biomechanical changes.

72-1354

THE FUNCTION OF THE SEAT AS A LINK BETWEEN MAN AND MOTOR VEHICLE

Hontschik, H. and Schmid, I. (Battelle-Institut e.V., Frankfurt am Main)

Automobiltech. Z 74 (4), 155-161 (Apr. 1972) 9 refs

Key Words: automobile seats

This paper concerns fitting of the seat and accommodating the occupant using vibration considerations in design. Experimental investigations of vehicle seats were conducted. (In German)

72-1355

NOISE ANNOYANCE SUSCEPTIBILITY

Moreira, N.M. and Bryan, M.E. (Audiology Res. Unit., Dept. Electrical Engr., Univ. Salford, Salford M5 4WT, England)

J. Sound and Vib. 21 (4), 449-462 (Apr. 22, 1972) 21 refs

Key Words: human factors engineering, noise tolerance

The variations of annoyance due to tape recorded noise are investigated in a group of 34 normal hearing subjects. It is found that there are significant differences between subjects in their rating of three different types of noise, 20 samples of which are played at levels varying from 55-95 dBA. It is also found that subjects are stable in their judgements of annoyance over a 2 month period. Those subjects most sensitive to noise show greater initial annoyance but their annoyance grows less rapidly with increasing noise level than that of those least sensitive to the noise. The former also tend to have steeper loudness functions than the latter; this result is in general support of the receptivity "hypothesis." Sensitivity to annoyance by noise is apparently quite strongly related to various measures of personality given by the Rorschach Projection Test. A tentative personality profile of a noise sensitive individual is proposed and some support for this is found from noise annoyance field studies and from individual loudness function data. It is suggested that in order to predict an individual's annoyance to a particular noise, it is necessary to know not only the level of the noise but also his personality.

72-1356

TEMPORARY HEARING LOSS INDUCED BY NOISE AND VIBRATION

Okada, A. and Miyake, H. (Dept. Public Health, Sapporo Medical Col., Sapporo, Japan)

J. Acoust. Soc. Amer. 51 (4), 1240-1248 (Apr. 1972) 15 refs

Key Words: human factors engineering, noise tolerance, vibration tolerance

A study is reported of five male students (19 to 20 years old) with normal ears who were exposed to (1) steady state noise, (2) vibration, and (3) noise and vibration at the same time. In a control experiment the subject sat beside the moving vibratory with earplugs and ear muffs. Temporary threshold shift (TTS) occurred after both 20 and 60 min of exposure to the vibration of acceleration 500 cm/sec^2 and frequency 5 Hz, which is regarded as a resonance frequency of the human body. The TTS by a steady state noise (101 dB sound pressure level (SPL) broadband) was increased by simultaneous vibration (500 cm/sec^2 and 5 Hz).

72-1357

DYNAMIC RESPONSE OF THE HAND-ARM SYSTEM TO A SINUSOIDAL INPUT

Reynolds, D.D. and Soedel, W. (Dept. Architectural Engr., Univ. Texas, Austin, Tex.)

J. Sound and Vib. 21 (3), 339-353 (Apr. 8, 1972) 24 refs

Key Words: biomechanics, dynamic response, human hand, measuring techniques, mechanical impedance

The mechanical impedance measuring technique is used to obtain data necessary to determine the vibration characteristics of the human hand. From this data, by means of a standard systems identification method, the values of the masses, springs and dampers are derived for an equivalent mass-spring-damper system which simulates the dynamic response of the hand. The influence of grip tightness, hand pressure upon the tool handle and arm position on the vibration response of the hand are examined. The results yield information necessary for determining meaningful hand vibration limit standards. To establish acceptable standards, it is necessary to monitor the vibration limit levels as a function of forcing frequency, the tightness of grip and the pressure of the hand on the tool handle. For, even though the vibration levels may decrease with a tighter grip or firmer hand pressure, the amplitude of the force transmitted through the hand may increase, resulting in an increased probability for injury.

72-1358

EFFECTS OF NOISE ON PEOPLE

U.S. Environmental Protection Agcy., Washington, D.C., NTID300.7 (Dec. 1971) 153 pp, 122 refs

Key Words: human factors engineering, noise tolerance

Noise has its most obvious effects on the ear and hearing since these are especially adapted to be sensitive to sound. One set of auditory effects is noticeable after a noise has passed, these are: temporary hearing loss, permanent hearing loss, and permanent injury to the inner ear. Another set of auditory effects is noticeable while a noise is present, these are: masking and interference with speech communication. Both of these sets of adverse auditory effects are discussed.

72-1359

NOISE FROM INDUSTRIAL PLANTS

L.S. Goodfriend Assoc., Spons. by U.S. Environ. Protection Agcy., Office of Noise Abatement and Control, Washington, D.C., NTID300.2 (Dec. 1971) 320 pp

Key Words: industry, noise generation, noise measurement, noise reduction

Industrial noises are measured and reported and various effects of these environmental noises on people are examined. The present state of the art in noise abatement in industry is surveyed and the planning currently going on for further means of achieving noise reduction is explored.

72-1360

THE SOCIAL IMPACT OF NOISE

The Natl. Bur. of Standards, Spons. by U.S. Environ. Protection Agcy., Office of Noise Abatement and Control, Washington, D.C., NTID300.11 (Dec. 1971) 25 pp, 29 refs

Key Words: human factors engineering, noise tolerance

Noise, because of its pervasive influence in all settings, activities and walks of life, has been often cited as a major source of annoyance and a threat to physical and mental health. This report discusses the social impact of noise, the extent and changing scope of the problem, and the medical and psychological effects thereof.

ISOLATION

72-1361
THE OPTIMIZATION OF UNDERCARRIAGE SUSPENSION CHARACTERISTICS BY A DETERMINISTIC METHOD
Reynolds, J.; Johns, D.J.; and Aird, R.J. (Loughborough Univ. Tech., England)
Symp. on Nonlinear Dynamics held at Loughborough Univ. Tech., England (Mar. 27-28, 1972) 31 pp, 20 refs

Key Words: aircraft, optimization, runway roughness, suspension systems, vibration response

Contemporary with progress in structural design and increase in size of modern aircraft, the severity of runway induced vibration has increased. This has resulted in a corresponding increase in fatigue damage and reduction of passenger and crew comfort. Factors affecting the choice of a suitable cost function describing these phenomena are discussed. Finally, a cost function is postulated and nonlinear equations representing the motion of a symmetric aeroplane when taxiing over a defined runway profile are derived. Optimum suspension characteristics which minimize this cost function deterministically are thus obtained. The use of a hybrid computer to facilitate speed of solution is discussed.

72-1362
OPTIMUM DESIGN OF A LINEAR MULTI-DEGREE-OF-FREEDOM SHOCK ISOLATION SYSTEM
Willmert, K.D. and Fox, R.L. (Clarkson Col. Tech., Potsdam, N.Y.)
J. Engr. Indus., Trans. ASME 94(2), 465-471 (May 1972) 10 ref

Key Words: mathematical programing, multidegree-of-freedom systems, optimization, shock isolators

A technique is presented, using mathematical programing methods, of determining the optimum values of the masses, spring and damping coefficients of a linear multidegree-of-freedom shock isolation system. The problem posed is the one-dimensional isolation of a mass from a shock of finite duration imposed by a supporting base. The work deals with the minimization of the maximum acceleration of the isolated mass subject to a constraint on the relative displacement between the mass and the base. In addition to the optimization of the M, C, and K coefficients, the problem of determining the optimum number of elements in the system (i.e., its topology) is also investigated. Discussion concerning this topic includes the question of uniqueness and absolute optimality of the solution.

MECHANICAL
(Also see Nos. 1211, 1227, 1250)

72-1363
IBM COPIER SCANNING SYSTEM
Beaty, D.A.; Hoskins, T.A.; Richards, T.H.; and Simpson, H.W. (IBM Office Prod. Div. Lab., Lexington, Ky.)
IBM J. Res. Develop. 16(3), 231-238 (May 1972)

Key Words: copying machines, machine development

The quality of the copy to be produced by the IBM Copier was of utmost importance in the machine development. This dictated that the amplitude of the vibrations of the document scanning system during scan be limited to a very low level. The design considerations, analysis, simulation, and instrumentation used to assure adequate performance of the system are described.

72-1364
INVESTIGATION ON THE DYNAMIC BEHAVIOR OF HYDROSTATIC DRIVES
Feldmann, D.G.
Konstruktion 23(11), 420-428 (1971) 1 ref

Key Words: dynamic response, hydrostatic drives

A calculation method is described, which is based on the mathematical description of the individual elements of the drive in the form of transfer matrixes. Frequency response measurements, which are compared to the calculation results, are used to determine the dynamics of the drive. (In German)

72-1365
DYNAMIC SHOCK PHENOMENA IN ROLLING MILLS
Kashay, A.M.; Voelker, F.C. and Smalley, A.J. (Jones & Laughlin Steel Corp., Cleveland, Ohio)
J. Engr. Indus., Trans. ASME 94(2), 647-659 (May 1972) 5 refs

Key Words: machining processes, metal working

Torsional shock phenomena in a large steel rolling mill are studied. Results of field measurements on a finishing stand are presented.

An analytical model of rolling mill systems is outlined, and the predictions of this model are compared with torque measurements. Satisfactory agreement is obtained. Certain significant factors affecting stress level in a rolling mill are established, and some recommendations are made for improving the maintenance performance of a mill.

72-1366

STABILITY CONDITIONS FOR VIBRATORS WITH RANDOM OR HARMONIC PARAMETRIC EXCITATION

Wedig, W. (D-75 Karlsruhe 41, Schinnrainstr. 15, Germany)

Ing. Arch. 41 (3), 157-167 (1972) 8 refs

Key Words: harmonic excitation, parametric excitation, random excitation, stability, vibrating structures

The conditions of mean square stability are determined approximately by means of the perturbation method for a clamped system with one degree of freedom, the parametric excitations of which are stationary narrow-band processes. According to these conditions the destabilizing effect of a random excitation is less, the more distant the average excitation frequency is from twice the natural frequency of the system. In the special case of a harmonic parametric excitation, the limits of mean square stability provide the instability region of the first order, which is well-known from the Mathieu equation. (In German)

OPTICAL

72-1367

SUMMARY OF NOISE PROGRAMS IN THE FEDERAL GOVERNMENT

U.S. Environ. Protection Agcy., Office of Noise Abatement and Control, Washington, D.C.

NTID300.10 (Dec. 1971)

Key Words: noise reduction

There is, at present, extensive ongoing activity by various federal agencies in noise abatement and control. Federal noise programs are the responsibility of a number of agencies, with the main thrust residing within the Department of Defense, National Aeronautics and Space Administration, Department of Health, Education and Welfare, Department of Housing and Urban Development, and now, the Environmental Protection Agency. There are continuing efforts by many individual agencies to accomplish short- and long-range objectives, commensurate with their mission. A brief description of the noise activities of federal agencies is presented.

72-1368

NOISE PROGRAMS OF PROFESSIONAL / INDUSTRIAL ORGANIZATIONS, UNIVERSITIES AND COLLEGES

U.S. Environ. Protection Agcy., Washington, D.C., NTID300.9 (Dec. 1971) 468 pp, 177 refs

Key Words: noise reduction, reviews

Information is provided concerning noise programs being sponsored or conducted directly or indirectly by professional, industrial, and voluntary associations (societies). Private industry research and educational and research programs are surveyed. A bibliography of pertinent publications relating to noise is included. The content of this report is based upon information of the Smithsonian Institute, the Acoustical Society of America, the Office of Noise Abatement and Control, and professional organizations.

PUMPS, TURBINES, FANS, COMPRESSORS

72-1369

STUDIES OF COHERENT AND INCOHERENT STRUCTURES OF NOISE OF AERODYNAMIC ORIGIN

DeBelleval, J.; Harel, P.; Lambourion, J.; and Perull, M.

Engl. Transl. of the 7th Intl. Cong. on Acoustics, Budapest, NASA-TT-F-14091 (Dec. 1971) 8 pp

Key Words: compressors, mathematical models, noise

With the aid of theoretical models currently in use, the coherent and incoherent structures of noise spectra of compressors are presented. The near pressure field of a compressor and the infrared emission of a hot jet are analyzed using spatial and temporal correlations in order to derive the structures of the sources.
N72-14700

72-1370

HOW TO ESTIMATE FAN NOISE
Graham, J. B. (Buffalo Forge Co., Buffalo, N. Y.)
S/V Sound and Vib. 6 (5), 24-27 (May 1972)

Key Words: fans, noise

A new method of fan noise estimation is provided. Specific sound power levels of all common types of fans are tabulated. A simple equation involving only fan delivery volume and pressure is used to correct these specific ratings to actual sound power levels generated. Recommendations for fan noise specifications to be used in purchasing are also provided.

72-1371

BLADE INTERACTION NOISE FROM LIFT FANS
Krishnappa, G. (Natl. Res. Council of Canada, Ottawa, Canada)
J. Acoust. Soc. Amer. 51 (5), 1464-1470 (May 1972) 11 refs

Key Words: blades, fans

The discrete frequency noise radiation from a single-stage lifting fan is analytically estimated from measured steady and unsteady aerodynamic data on the fan and compared with the measured noise levels. Unsteady forces acting on the stator blades are calculated from measurements of the rotor blades' wake, using a hot wire anemometer. The viscous interaction noise estimated is compared with the potential interaction noise from the rotor blades. Rotor potential flow interaction and stator viscous interaction noise both seem to be important in the case of close rotor-stator spacing. The estimated results show a reasonable agreement with the measured results.

72-1372

IN-DUCT INVESTIGATION OF SUBSONIC FAN "ROTOR ALONE" NOISE
Moore, C. J. (Rolls-Royce (1971) Ltd., Advanced Res. Labs., P.O. Box 31, Derby, England)
J. Acoust. Soc. Amer. 51 (5), 1471-1482 (May 1971) 5 refs

Key Words: ducts, noise generation, rotors

The production of tones by an isolated rotor interacting with fluctuating and steady flow distortions is discussed and a method of separating the steady components is explained. Circumferential, radial, and axial microphone traverses are made in the duct of a 1m diam four-bladed subsonic ventilation fan with no stators. The steady components of the rotor tones are measured and phase related to the shaft rotation. The results show that the acoustic field close to the rotor is dominated by its steady force field; at any multiple of rotational frequency, the basic mode is present, having a number of lobes equal to the rotational frequency harmonic order. At greater axial distances from the rotor, the basic mode decays, leaving only modes of low circumferential order at the intake. The estimated power in these modes is in agreement with the acoustic power measured from farfield traverses. The loading spectrum of the fan is determined from the acoustic modes in the intake and compared with the spectrum used in helicopter noise theory.

72-1373

SOURCES OF NOISE IN AXIAL FLOW FANS
Mugridge, B. D. and Morfey, C. L. (Inst. Sound and Vib. Res., The Univ. Southampton, Southampton, SO9 5NH, United Kingdom)
J. Acoust. Soc. Amer. 51 (5), 1411-1426 (May 1972) 55 refs

Key Words: fans, noise generation

Note: For another presentation of this material see Abstract No. 72-151.

Experiments and theory relating to fan noise sources are reviewed with emphasis on axial flow machines. At supersonic rotor speeds, the steady shock pattern attached to a rotor is an efficient radiator of sound. In most practical cases of subsonic rotor operation, however, direct radiation from the rotor-locked pressure field is negligible compared with the indirect radiation, or scattering, caused by circumferential distortions in the steady flow field surrounding the rotor. Random timewise modulation of the distortion changes the scattered spectrum from discrete to continuous with a gradual progression from narrowband tones to broadband noise as the modulation bandwidth is increased. Similar scattering occurs when a nonuniform unsteady flow impinges on stator vanes, but here the radiated frequency is that of the impinging flow. Finally, for blades operating in flows free from circumferential distortions, self-generated turbulence becomes an important source of noise. The paper describes the physical mechanisms involved in each of these processes, including the generation of unsteady lift by turbulence. Order-of-magnitude sound-power estimates are compared where possible with experiment.

RAIL

72-1374

DYNAMIC RAILCAR SIMULATION PROGRAM
MELPAR - An American Standard Co.,
7700 Arlington Blvd., Falls Church, Va.)
FRA-RT-20-24 (Feb. 1970) 247 pp, 5 refs

Key Words: computer programs, digital simulation, railroad trains

A generalized digital simulation has been programed in the basic FORTRAN language for calculating the motions and forces during operation of a multimembered railcar. The railcar is driven at selected speeds along a pair of rails represented by recorded numerical measurements. All massive components of the railcar are treated as general mechanical members with six degrees of freedom, coupled to each other by an arbitrary set of linear elements or a programed set of nonlinear functions having given spring rates, damping constants, etc. The model includes simulation of truck "hunting" phenomena with cylindrical or tapered wheel treads and simulation of the compliance properties of the rail roadbed.
PB 192886

RECIPROCATING MACHINE

(Also see No. 1245)

72-1375

SOUNDPROOFING OF ENGINES
Rauch, J.
Engl. Transl. of Min. de l'Air, Paris, France
Rept. No. 418 NASA-TT-F-14063 (Dec. 1971)
147 pp

Key Words: automobile engines, engine noise, noise reduction

The acoustic principles are presented for attenuating automobile engine noise. The various aspects of soundproofing exhaust noise are discussed, along with the means for low-pitch sound absorption. A terminal reflection muffler system for total noise suppression is described. An admittance type muffler is also considered, and the requisite dynamic and acoustic conditions for its use are determined. Different materials are proposed for use as sound absorbers and the case of acoustic supercharging and optimization is studied.
N72-14698

ROAD

(Also see Nos. 1345, 1265, 1340, 1354)

72-1376

NOISE AND INFLATABLE RESTRAINT SYSTEMS
Allen, C.H.; Bruce, R.D.; Dietrich, C.W.; and Pearsons, K.S.
Bolt Beranek and Newman, Inc.,
Cambridge, Mass. BBN-2020 (Apr. 1971) 83 pp

Key Words: air bags (safety restraint systems), automobiles, noise, noise tolerance

Results from a limited number of tests of prototype inflatable restraint systems, with full complement air bag deployment, are compared with a tentative criteria for noise exposure. Based on the tentative criteria, it is estimated that some of the population may experience hearing damage when exposed to noise of the level produced by the prototype systems (172 to 179 dB peak pressure levels).
PB 207285

72-1377

PRESENT STATE OF DEVELOPMENT OF THE VW EXPERIMENTAL SAFETY VEHICLE -- PART 2
Appel, A.; Fiala, E.; Willumeit, H.-P.
Automobiltech. Z. 74 (3), 124-129 (Mar. 1972)

Key Words: automobiles, collision research, safety restraint systems, test data

Test results with restraint systems for vehicle occupants are presented. Knee protection belts used in combination with air bags and lap belts are discussed. Front end impact tests against a rigid pole were used. (In German)

72-1378

PRESENT STATE OF DEVELOPMENT OF THE VW EXPERIMENTAL SAFETY VEHICLE -- PART 3
Appel, H.; Fiala, E.; and Willumeit, H.-P.
Automobiltech. Z. 74 (4), 162-165 (Apr. 1972)

Key Words: automobiles, collision research

Further test results on rear and and side impacts are presented. Safety as an economic problem is discussed. (In German)

72-1379

DUAL-FUEL MOTOR VEHICLE SAFETY IMPACT TESTING
Enserink, E.
Dynamic Science, Phoenix, Ariz.
(Nov. 1971) 228 pp

Key Words: automobiles, collision research, fire hazards, impact tests

Impact testing is reported which was conducted to determine potential fire or other hazards resulting from rupture of fuel circuitry and/or tank retention failure in compressed natural gas and liquid natural gas systems. Following an engineering evaluation of the data, an analysis of the systems is conducted to determine if the normal occupant survivability limit of the vehicles in crash situations was adversely affected. Recommendations for improving the crashworthiness of the system are formulated after a fuel system analysis based on the test data and consideration of other crash modes to which the vehicles could be subjected.
PB 207668

72-1380

HSRI THREE-DIMENSIONAL CRASH VICTIM SIMULATOR: ANALYSIS, VERIFICATION, AND USERS' MANUAL AND PICTORIAL SECTION
Robbins, D.H.; Bennett, R.O.; and Roberts, V.L.
Mich. Univ., Highway Safety Res Inst., Ann Arbor, Mich., HSRI-Bio-M-70-9 (June 1971) 285 pp

Key Words: collision research, mathematical models, occupant simulation

The report deals with the development and use of mathematical models for the simulation of automotive occupant kinematics in the event of a collision. This model was developed as a tool to study advanced concepts and designs of seat restraint systems from the viewpoint of occupant protection. After a discussion of the state of the art of mathematical modeling of the crash victim, an analytical description of the HSRI three-dimensional crash victim simulator is presented. A detailed users' manual is included.
PB 208242

72-1381

DEVELOPMENT AND TESTING OF INTEGRATED SEAT RESTRAINT SYSTEMS
Robbins, D.H.; Roberts, V.L.; Henke, A.W.; Raney, D. F.; and Bennett, R.O.
Mich. Univ., Highway Safety Res. Inst., Ann Arbor, Mich. HSRI-71-122 (June 1971) 78 pp

Key Words: collision research, mathematical models, safety restraint systems, test data

The objective of the research was to develop, fabricate and test seat and restraint system combinations designed to offer a level of protection exceeding that found in current production seats and restraint systems. A series of analytical studies using two- and three-dimensional mathematical models of an automobile crash victim is described. These studies, in combination with a survey of the state of the art of seating and restraint systems are used to formulate design concepts of integrated seat restraint systems. The most promising of the active systems is fabricated and subjected to front, oblique, side and rear impact tests using anthropometric dummies. The results of these tests are compared with current production seating systems and with the initial predictions of the mathematical models. Recommendations are made concerning performance requirements and compliance procedures for integrated seat restraint systems and for passive front seat occupant restraint systems.
PB 206589

72-1382

TEST FOR VEHICLE ROLLOVER PROCEDURE
Young, R. and Scheuerman, H.
Natl. Aviation Facilities Experimental Ctr., Atlantic City, N.J. NAFEC-171-1 (Nov. 1971) 63 pp

Key Words: automobiles, collision research, testing techniques

A series of tests are performed using a number of different sizes and configurations of recent models of motor vehicles to verify the rollover procedure required in the Occupant Crash Protection Standard. The tests proved the adequacy of this procedure to produce repeatable rollovers and to demonstrate the applicability over a large range of vehicle sizes and configurations.
PB 207667

72-1383

INVESTIGATION OF MOTOR VEHICLE PERFORMANCE STANDARDS FOR CRASHWORTHINESS OF VEHICLE STRUCTURE
Fairchild Hiller Corp , Republic Aviation Div., Farmingdale, N.Y. FHR-3445 (Jan. 1968) 265 pp

Key Words: collision research, motor vehicles, standards

A study to develop and document a detailed text on all aspects of structural design in motor vehicles related to protecting occupants of vehicles from serious injuries in crashes is described. This knowledge will provide a basis for safety standards for the performance of motor vehicle structures and will assist with certification procedures. The program discussion is divided into plans for state of the art; establishing performance criteria, qualification procedures, and performance standards; development of analytical tools and techniques; updating and expanding a data base; and consultation liaison during advanced notice period of proposed rule making.
PB 207302

72-1384

DEVELOPMENT OF AN ANALYTICAL APPROACH TO HIGHWAY BARRIER DESIGN AND EVALUATION
Bur. of Physical Res., Dept. of Public Works, New York State (May 1963) 304 pp

Key Words: collision research, guardrails, mathematical models

Several agencies have investigated the protection offered by existing barrier systems and the capabilities of new designs. The majority of such studies have involved either static or dynamic testing of barrier components, model barrier tests or full-scale tests. This investigation reviews the existing information, develops a rational method of evaluating barrier performance and verified the predicted vehicle reaction with full-scale tests. Mathematical models are developed to describe the relationship between applied horizontal load and the resulting lateral deflection for three general classes of highway barriers. Vehicle trajectory, during impact with a barrier, is predicted by a fourth mathematical model.
PB 208342

72-1385

THE SKIDDING OF VEHICLES, A DYNAMIC ANALYSIS
Carnegie-Mellon Univ., Pittsburgh, Pa. (May 1971) 12 pp

Key Words: automobiles

Analytical results are reported on the steady state steering response of automobile under disturbances such as sudden braking, or accelerating in a straight path, road camber, the transient response of steering inputs, and the effects of road and tire characteristics on the automobile. A general model of an automobile is set up, the criteria of skidding is established, and the factors that influence stability, handling, and skidding of an automobile are determined. As a result of past work many factors of man, vehicle and highway interchange can be connected so that predictions may be made of what happens up to the onset of skidding.
PB 208090

72-1386

TEST AND EVALUATION OF VEHICLE ARRESTING, ENERGY ABSORBING, AND IMPACT ATTENUATION SYSTEMS
Tex. Transportation Inst., College Station, Tex. (Nov. 1971) 268 pp

Key Words: automobiles, collision research, energy absorption, impact tests

Full-scale vehicle crash tests are conducted to evaluate a variety of vehicle arresting, redirecting, energy absorbing, and impact attenuation systems. In addition, research work is done to establish the feasibility of using steel drums, lightweight cellular concrete, corrugated metal pipe, and concrete pipe as energy absorbing materials for such vehicle impact attenuation systems. Several of these vehicle impact attenuation systems are noted to have been successfully implemented on the nation's highways.
PB 207840

ROTORS

(Also see No. 1288)

72-1387

DYNAMIC BALANCING
Baxter, R.L. (IRD Mechanalysis, Inc., Columbus, Ohio)
S/V Sound and Vib. 6(4), 30-33
(Apr. 1972) 7 refs

Key Words: dynamic balancing, machinery

The most common source of excessive vibration in rotating machinery is dynamic unbalance. Standard dynamic balancing techniques can be applied "in-place" or with a rotating component mounted on a test stand. Machinery vibration criteria and balancing equipment are reviewed relative to specific applications.

72-1388

ON THE USE OF BALANCING MACHINES FOR FLEXIBLE ROTORS
Bishop, R.E.D. and Parkinson, A.G. (Univ. Col London, London, England)
J. Engr. Indus., Trans. ASME 94(2), 561-576 (May 1972) 21 refs

Key Words: balancing machines, rotors, shafts

During the last decade or so a variety of methods has been devised and adopted for balancing flexible rotating shafts. These techniques fall into two distinct classes depending upon whether or not the shaft is also balanced as a rigid body. The relative merits of the two approaches have been the subject of much discussion, and this paper is an attempt to clarify the points at issue.

72-1389

THE ROLE OF MATERIAL DAMPING IN THE STABILITY OF ROTATING SYSTEMS
Genin, J. and Maybee, J.S. (Purdue Univ., Lafayette, Ind.)
J. Sound and Vib. 21(4), 399-404
(Apr. 22, 1972) 7 refs

Key Words: material damping, rotating structures, shafts, stability

In this paper a whirling shaft is considered which is modeled as an elastic continuum subject to general descriptions of the initial conditions and broad descriptions of the boundary conditions. Material damping tends to destabilize the system for this class of dynamic systems when the impressed angular velocity exceeds the fundamental critical velocity of the system.

72-1390

VIBRATION AND STABILITY TESTS ON FRICTION BEARING BEDDED ROTORS
Glienicke, J.
MTZ Motortech. Z. 33(4), 135-139
(Apr. 1972) 4 refs

Key Words: friction bearings, rotors, vibration tests

Vibration and stability tests of rotors mounted on friction bearings are discussed. Test facilities and measurement techniques are described. The accuracy of vibration calculations, based on the elasticity and damping constants of the lubricating film, is verified by comparison with the measured and calculated imbalance vibrations. Also, by means of systematic experimental and theoretical investigation of the natural frequencies of rotors mounted on friction bearings, the sufficiency of the present stability theories in all cases for such systems is determined. (In German)

72-1391

ON THE DYNAMIC RESPONSE OF AXIALLY COUPLED TURBOROTORS
Lemke, D.G. and Trumpler, P.R. (Univ. Ill. at Chicago Circle, Chicago, Ill.)
J. Engr. Indus., Trans. ASME 94(2), 507-516
(May 1972) 9 refs

Key Words: dynamic response, rotors, turbine components

An analytical investigation of the effect of coupling characteristics on the response of axially coupled sets of turborotors is presented. The results of this investigation are based on transfer matrix techniques which utilize a generalized machine element matrix and coupling fixity matrix. Disk inertia, gyroscopic effects, and both shaft and coupling orthotropy are included in this study. An example, utilizing two axially coupled modified Prohl rotors, demonstrates that the nature of the coupling has a significant effect on the response characteristics of the rotor set. This is accomplished by varying coupling fixity from zero to infinite in an isotropic and orthotropic manner. As a consequence, this result implies that the coupling must be taken into account throughout the entire mechanical design effort devoted to the rotor system. In particular, the coupling must be considered when writing balancing specifications and during actual balancing of the rotor set. Finally, it is shown that the axial coupling of turborotors can result in the unloading of particular bearings of the turborotor set at discrete speeds. Such unloading may initiate journal instabilities that are known to be associated with light loading conditions.

72-1392

WIND TUNNEL TEST OF THE AERODYNAMIC AND DYNAMICS OF ROTOR SPIN-UP, STOPPING AND FOLDING ON A SEMISPAN FOLDING TILT-ROTOR MODEL, VOLUME VII

Van Wagensveld, D.; McHugh, F.J.; Delarm, L.N.; Lapinski, W.L.; and Magee, J.P.
Boeing Co., Vertol Div., Philadelphia, Pa.,
AFFDL-TR-71-62-Vol-7 (Oct. 1971) 402 pp

Key Words: aerodynamic characteristics, rotary wings, test models

Wind tunnel test data obtained with a 1/9-scale semispan, unpowered, dynamically scaled Model 213 stowed/tilt rotor are reported. The objectives are to obtain aerodynamic, structural, and dynamics data during the spin-up, feather and blade fold cycles of this vehicle.

SELF-EXCITED

(Also see Nos. 1311, 1374)

SHIP

(Also see No. 1226)

72-1393

PREDICTION OF THREE-DIMENSIONAL PRESSURE DISTRIBUTIONS OF V-SHAPED PRISMATIC WEDGES DURING IMPACT OR PLANING

Gray, H.P.; Allen, R.G.; and Jones, R.R.
Naval Ship Res. and Dev. Ctr., Bethesda, Md.
NSRDC-3795 (Feb. 1972) 36 pp

Key Words: computer program, hydrodynamic response, ship hulls

A computer program which calculates the water pressure distribution on V-bottom prismatic wedges during impact or planing is reported. The method of computation is based on previously published semiempirical procedures with several modifications that facilitate programing and result in close correlation to recently published experimental data. The prismatic wedge may have any positive value of trim, deadrise angle, and wetted length. The pressure distribution for the entire hull or any given section of the hull may be calculated in specified increments by using the appropriate input data. Results obtained from the program are in reasonable agreement with certain published experimental planing data.
AD-739328

72-1394

ACOUSTIC RADIATION FROM A DOUBLE HULL STRUCTURE

Pollack, M.L. and Klosner, J.M.
Polytechnic Inst of Brooklyn, Dept. of Aerosp. Engr. and Appl. Mech., Brooklyn, N.Y.
PIBAL-72-5 (Feb. 1972) 37 pp

Key Words: ship hulls, sound waves, submarines

Accurate information on the transmission of sound through water is useful in designing sonar gear for echo ranging and in providing helpful data for submarine tactics. During the last decade or two, a number of theoretical investigations have been carried out in which the radiation due to submarine hull vibration has been analyzed. The present study is a continuation of this effort to obtain a basic understanding of the radiation characteristics of structures. Of prime interest is the transmission loss characteristics of a double hull construction.
AD-739351

STRUCTURAL

(Also see Nos. 1202, 1218, 1224)

72-1395

AUTOPARAMETRIC INTERACTIONS IN STRUCTURES

Barr, A.D.S. and Nelson, D.J. (Univ. Edinburgh, Edinburgh, Scotland)
Symp. on Nonlinear Dynamics held at Loughborough Univ. Tech., England (Mar. 27-28, 1972) 20 pp, 6 refs

Key Words: coupled response, periodic response

The paper considers the steady state response of a general structure under harmonic forcing near one of the frequencies involved in the internal resonance relation. It is found that all the related modes enter into the response in varying degrees and that sometimes the response of the mode that would be expected to be excited most is suppressed by the existence of the others. Some simulation experiments and a model test illustrating the nature of the response are reported briefly.

72-1396

FREE VIBRATIONS OF A COUPLED FLUID/STRUCTURAL SYSTEM
Chen, S.S. (Argonne Natl. Lab., 9700 South Cass Ave., Argonne, Ill.)
J. Sound and Vib. 21(4), 387-398 (Apr. 22, 1972) 6 refs

Key Words: coupled systems, interaction: structure-medium, natural frequency

The beamlike vibration of a fluid-structural system consisting of a cylindrical rod submerged in an ideal fluid enclosed by a cylindrical shell is studied analytically. A method is proposed to find the natural frequency. Numerical results are presented to show the effects of various parameters, and an approximate expression is given for the fundamental frequency of the coupled system.

72-1397

DYNAMIC FIELD ANALYSIS OF TORSIONLESS GRIDS
Rao, H.V.S.G. and Smith, J.C. (Civil Engr., W. Va. Univ., Morgantown, W.Va.)
ASCE J. Engr. Mech. Div. 98(3), 679-693 (June 1972) 6 refs

Key Words: beam grids, distributed parameter method, lumped parameter method

Closed form solutions for the nodal deflections and bending moments of a uniform grid which is simply supported and, when subjected to out-of-plane dynamic loads is either simply supported or beam supported, are presented. By degenerating the governing equations of the grid, the natural frequencies of the grid and the response of the grid to static loading are also obtained. Exact solutions of an approximate formulation (lumped masses) are presented and compared to the exact solutions of the exact formulation (distributed masses). Numerical comparison of a lumped mass grid vs a distributed mass grid is given. A method is introduced for the field analysis of latticed systems. A general governing summation equation is written and by expressing the nodal unknowns in terms of series and applying orthogonality conditions, the equation is solved in closed form to obtain the nodal unknowns. The method of analysis can be routinely extended to nonuniform grids by generating the full matrix defined by the summation equation and solving the resulting set of simultaneous equations (open form solution).

72-1398

VIBRATION AND STRAIN-INDUCED NOISE FROM THE ELF FLEXIBLE LOOP ANTENNA
Manning, J.E.
Mass. Inst. Tech., Lincoln Lab., Lexington, Mass. ESD-TR-71-321 (Dec. 1971) 36 pp

Key Words: antennas, vibration response

Measurements made on a segment of the ELF flexible loop antenna to study its electrical sensitivity to vibration and strain are reported. Transfer functions for the output voltage resulting from various types of vibration and strain are determined as functions of frequency, bias current, and orientation with respect to the gravitational field. Based on these laboratory measurements, it is tentatively concluded that the principle source of noise for the flexible loop antenna towed from a submarine is longitudinal strain.
AD-737093

72-1399

DYNAMICS OF GUYED TOWERS
McCaffrey, R.J and Hartmann, A.J.
(Townsend and Assoc., Chicago, Ill.)
ASCE J. Struct. Div. 98(6), 1309-1323 (June 1972) 8 refs

Key Words: guyed structures, mathematical models, towers

Some of the parameters used in developing the mathematical model for a guyed tower are studied. The model used herein is based on the geometric and structural properties of WTMJ television tower located in Milwaukee, Wisconsin. To simplify the analysis, it is assumed that the mast can vibrate only in the x-x plane and that all the guys framing into the mast at a given level have the same dynamic characteristics. The parameters considered are the effects of: (1) assuming a parabolic rather than a catenary static deflection shape for the guy; (2) the number of degrees of freedom of the mast; (3) ambient temperature; and (4) higher guy modes, such as second and third, on the free vibration behavior.

72-1400

DETERMINATION OF FIXED-BASE NATURAL FREQUENCIES OF A COMPOSITE STRUCTURE OR SUBSTRUCTURES: EXPERIMENT AND APPLICATIONS

Ni, C.C. and Layher, J.P.
Naval Res. Lab., Washington, D.C.,
Rept. No. NRL-7362 (Dec. 1971) 21 pp

Key Words: beams, natural frequencies, testing techniques

A generalized method reported earlier for determining the fixed-base natural frequencies of an in situ or laboratory mechanical structure or substructure is tested by experiments. The test structure is composed of a simple steel beam on three supports which were mounted on flexible members of a trusslike frame. The fixed-base natural frequencies of the lowest two modes of the test beam are determined by the aforementioned semianalytical method. Theoretical calculations and a standard resonance test are also performed for comparison. Results confirm the applicability and usefulness of the developed method, as predicted by the theoretical analysis.
AD-737193

72-1401

EXPECTED FATIGUE DAMAGE OF SEISMIC STRUCTURES

Tang, J.P. and Yao, J.T.P. (Civil Engr., Purdue Univ., Lafayette, Ind.)
ASCE J. Engr. Mech. Div. 98(3), 695-709 (June 1972) 37 refs

Key Words: earthquake damage, fatigue life, seismic excitation

The statistics of fatigue life for structures subjected to earthquake excitation are studied. Furthermore, the design concept of the fatigue damage factor is expressed. The envelope functions which represent various types of simulated earthquakes, as proposed by Jennings, et al, are used to compute the expected fatigue damage of seismic structures numerically with the use of an IBM 360-67 computer.

72-1402

THE EFFECTS OF SONIC BOOM AND SIMILAR IMPULSIVE NOISE ON STRUCTURES

Natl. Bur. Standards, Spons. by U.S. Environ. Protection Agcy., Office of Noise Abatement and Control, Washington, D.C.
NTID300.12 (Dec. 1971) 19 pp, 18 refs

Key Words: buildings, sonic boom

A brief discussion is given of the physical nature of sonic booms, and other impulsive noises, and the parameters, such as overpressure, duration, and mechanical impulse, which are used to characterize booms. This is followed by an overview of the response of structures, particularly buildings, to sonic booms and a review of the damage history observed resulting from supersonic overflights. The report concludes with a summary of the observed effects of impulsive noise on terrain and natural structures.

TRANSMISSION

72-1403

WAVES AND VIBRATIONS IN CURVED ULTRASONIC TRANSMISSION LINES

Graff, K.F. (Ohio State Univ., Columbus, Ohio)
Ultrasonics 10(2), 77-82 (Mar. 1972) 22 refs

Key Words: transmission lines, vibration response, wave propagation

Curved transmission lines are used in several areas of ultrasonic and power sonic applications such as delay lines and sonic wave drawing apparatus. The optimum design of such applications requires knowledge of the vibration and wave propagation characteristics of such devices, but theoretical developments in this area have been generally lacking. A review of some recent developments is given, in addition to brief remarks on desired future work.

72-1404

TORSIONAL RESPONSE OF A GEAR TRAIN SYSTEM

Wang, S.M. and More, I.E., Jr. (Control Data Corp., Valley Forge Div., Norristown, Pa.)
J. Engr. Indus., Trans. ASME 94(2), 583-594 (May 1972) 13 refs

Key Words: computer programs, experimental results, gears, torsional response, transfer matrix method

A gear train system can be represented by a spring-mass system having many degrees of freedom. The transfer matrix technique is applied to give the static and dynamic torsional response of a general gear train system. The method develops, directly from drawings, all equations necessary for the solution of the problem. Effects that can be included in the formulation are the gear tooth stiffnesses, gear web stiffness, nonuniform cross section of shafts, external torques, special types of joints, general boundary conditions, and multigeared branched systems. A general computer program is written

to obtain numerical solutions. The experimental evaluation of a gear train system is conducted using an electrohydraulic exciter and an Automatic Mechanical Impedance Transfer Function Analyzer System (TFA). The spindle shaft of a nonrotating, preloaded gear train system is excited by applied forces in the bending and torsional directions. The computed torsional natural frequencies and mode shapes correlate at low frequencies. At high frequencies, there is a coupling effect between the motion in torsion and transverse motions. The presented analytical and experimental technique may be a practical method to evaluate the torsional response of a gear train system.

TURBOMACHINERY

72-1405
AERODYNAMIC DAMPING IN TURBOMACHINERY
Cavaille, Y. (Electricite De France, Chatou, France)
ASME Paper No. 72-GT-8

Key Words: aerodynamic damping, turbomachinery

An experimental study of aerodynamic damping carried out on an axial compressor is described in which stagger angle, pressure ratio, and relative velocity are varied. The study utilizes explosive charges buried in the tip of the blade to provide excitation and determines the damping by measuring the log decrement of the vibrations. The blade vibratory mode is pure bending.

72-1406
EXPLORATORY INVESTIGATION OF JET ENGINE SILENCING WITH PLUG NOZZLE CONFIGURATIONS
Scharton, T.D.; Pinkel, B.; and Tomooka, S. (Bolt Beranek and Newman Inc., Canoga Park, Calif.)
AIAA 10th Aerosp. Sci. Meeting, San Diego, Calif. (Jan. 17-19, 1972) AIAA Paper No. 72-160, 6 pp, 9 refs

Key Words: engine noise, noise reduction

The acoustic and thrust performances of various plug nozzle suppressor configurations are experimentally compared with the performances of a conventional multitube suppressor and a reference converging-diverging nozzle. Measurements of the one-third octave band radiated sound power and the acoustic directivity for a jet Mach number of 1.4 indicate that the plug nozzle suppressor configuration and a multitube suppressor configuration each provide approx 10 dB noise suppression relative to the reference nozzle. Preliminary thrust measurements suggest that the plug nozzle suppressor offers less thrust loss than multitube suppressors.

USEFUL APPLICATION
(Also see Nos. 1259, 1260)

72-1407
DETERMINATION OF THE ACOUSTIC LOAD IMPEDANCE IN THE ULTRASONIC MACHINING OF GLASS
Boidek, S.A.; Golyamina, I.P.; and Margolin, V.S. (Acoustics Inst., Acad. Sci. of the USSR, Moscow, Russia)
Sov. Phys., Acoust. 17(4), 460-463 (Apr./June 1972) (Engl. Transl. Akust. Zh. 17(4), 540-544, Oct./Dec. 1971) 9 refs

Key Words: machine tools, ultrasonic techniques

The parameters of the equivalent circuit of the vibratory system of an ultrasonic machine tool used to cut glass are determined, and its efficiency and acoustic-load impedance are estimated by means of an apparatus capable of generating impedance diagrams of the transducers in operation.

72-1408
DYNAMIC CHARACTERISTICS OF A VIBRATING PLATE COMPACTOR
Fu, C.C. and Paul, B. (Ingersoll-Rand Res., Inc., Princeton, N.J.)
J. Engr. Indus., Trans. ASME 94(2), 629-636 (May 1972) 12 refs

Key Words: digital computation techniques, periodic response, soils, vibratory compacting, vibratory tools

Vibrating plate soil compactors are widely used in building and road construction, yet no adequate dynamic theory exists to predict vital performance characteristics such as frequency of impacts, speed of forward travel, power delivered to the soil, etc. In this paper, a model is defined which takes into account the intrinsically nonlinear features of the process. It is shown that for certain values of system parameters, it is possible to have periodic behavior of the system where the period of the motion is an integer

multiple of the period of the exciting force. The dynamic stability of these "simple" nonsynchronous steady state solutions is investigated, and the stability boundaries in parameter space are found. It is shown how the problem may be investigated via a digital computer. In general, the forward speed and power delivered to the soil are found to be sensitive functions of the ratio of exciting force to dead weight. The power delivered to the soil tends to be a maximum when the exciting force is approximately twice the dead weight.

72-1409

ANALOG AND DIGITAL ANALYSIS AND SYNTHESIS OF OSCILLATORY TRACKS

Mansour, W.M. (Univ. Waterloo, Waterloo, Ontario, Canada)

J. Engr. Indus., Trans. ASME 94(2), 488-494 (May 1972) 7 refs

Key Words: analog computation, digital computation, materials handling equipment, structural synthesis, vibratory tools

A vibratory feeder is essentially an inclined plane which is subjected to an acceleration cycle. It is used to transport components or material, after giving them the proper orientation or mixing. Usually rapid upward motion is desired. The purpose of this paper is to provide the designer with some basic tools that enable him to analyze, and effectively choose, the basic parameters pertaining to a vibratory feeder. Programs to solve specific cases are also included. The digital and analog approaches are used with equal emphasis whenever applicable.

AUTHOR INDEX

BOOKS

UNDERWATER ACOUSTICS

Leon Camp (Richard Stern and B.M. Brown, contributing authors)
Wiley-Interscience, New York, N.Y. (1970)

According to the author's preface, this book has evolved as a consequence of the "short course" in underwater acoustics offered over a number of years by the University of California, Los Angeles. In view of the extensive scope of the topic, it is clear that the alternative to a multi-volume edition is either a general introduction to fundamentals or a more complete discussion of limited topics. The author's intent has thus been to present briefly the fundamentals that are deemed essential to an understanding of basic electroacoustic transduction techniques and to the design of the more commonly used transducer elements. Supplemental information relevant to phenomena encountered in array design, underwater sound propagation, and signal processing is also included.

The first two chapters of this book deal with the elementary mechanics of vibration and properties of distributed systems. The treatment of the distributed systems consists primarily of discussion of longitudinal wave propagation in uniform bars and composite longitudinal vibrators.

Chapters 3 and 4 (by contributing author Richard Stern) contain an excellent and concise exposition of the fundamentals of wave acoustics and basic ray acoustics.

Chapter 5 deals with electroacoustic transduction, and to some extent, consists largely of adaptation of material drawn from F. V. Hunt's Electoacoustics.

The sixth chapter deals specifically with the properties of magnetostrictive and piezoelectric systems. Numerous examples of transducer elements such as magnetostrictive scrolls, ceramic rings, longitudinal vibrators, side-plated bars, and flexural disks are included. These examples are apt to be of particular interest to those directly concerned with the design of transducers.

Chapters 7, 8, and 9 treat radiation patterns, transducer calibration, and the basic principles of active and passive sonar systems. It is convenient to find a brief presentation of this important material under one cover, although much of this material is presented in more detail in such standard reference texts such as Underwater Acoustics II, by Albers; Sonics, by Hueter and Bolt; or Fundamentals of Acoustics, by Frey.

The concluding chapter (by contributing author B. M. Brown) presents an introduction to the theory of signal processing, including a description of the implementation of signal processors.

Because such a large portion of this book is directed toward developing an understanding of the principles of underwater electroacoustic transducer design, it is clear that the title is rather inappropriate. While the scope of this material is undoubtedly appropriate for use in "short courses", this book is neither an adequate text on "underwater acoustics" per se, nor a completely adequate treatise on transducer design.

This inadequacy may be a consequence of multiple authorship and inadequate editing. There is a certain amount of redundancy, which more careful editing might have eliminated. For example, Secs. 2.3.1 and 3.7.1, in effect, both treat the problem of plane waves normally incident upon the boundary between two media. A perceptive editor ought to have eliminated the indiscriminate usage of the i and j notations in various sections, as well as numerous errata, ranging from the omission of a factor e^{-jkr_0} in Eqs. 7.16 and 7.17, or the absurd acceptance of a table of elastic constants listed as a "Table of Four-Place Logarithms." There are many incomplete or incorrect footnotes (including a reference to the work of a "Lord Layleigh"), as well as a reference to the work of "Winte" within the text of a page while a related footnote on the same page refers to a paper by "Winte and Thuras", where clearly Wente is the correct spelling.

It is regrettable that this book has apparently received such inadequate editorial and coordinative attention, for it is clear that the general selection of subject matter has been guided by thoughtful review of the needs of practicing acoustical engineers. Some acousticians may also be distressed by expositions which are marred either by imprecise use of technical terminology or by the implicit or explicit appearance of opinion, where a more factual and accurate exposition is required. It is obviously dangerous to imply that an expression for the mechanical Q of a vibratory system is a "valuable measure of the quality" without more explicit specification of the sense in which "quality" is meant; yet there are many instances of such stylistic imprecision. It also does a considerable injustice to European members of the scientific community to state that "The science of underwater acoustics ... had its origin in the development of the technology of ocean surveilance by the Department of Defense."

These inadequacies and pecularities of this volume are unfortunate, for it is this reviewer's opinion that a distinct need exists for an accurate and thorough presentation of the subject matter of electroacoustic transducer design. In view of much current activity in audio engineering, as well as in underwater acoustics, such a volume should include material related to the design of microphones and loudspeakers, as well as of hydrophones and underwater projectors, and might also include an up-to-date presentation of design properties of typical stereophonic phonograph cartridges, because of the close similarities of these electroacoustical and electromechanical transducers. The present volume does not fill this need.

David S. Pallett
The Pa. State Univ.
Univ. Park, Pa. 16802
Courtesy of J. Acoust. Soc. Am.

DYNAMICS OF SATELLITES
Bruno Morando, ed.
Proceedings of Symposium
on the Dynamics of Satellites
Prague, Czechoslovakia
May 20-24, 1969

This book presents the proceedings of a symposium on the dynamics of satellites in Prague in May 1969 during the twelfth COSPAR meeting. The symposium was sponsored by the International Astronomical Union, the International Association of Geodesy, the International Union of Theoretical and Applied Mechanics and the Committee on Space Research.

The results of this symposium are particularly interesting since they come at a time of unusually high activity in the application of artificial satellites to the refinement of physical measurements of our own planet Earth in addition to preliminary attempts to improve upon the measure of extraterrestrial bodies.

The 38 papers authored by 46 experts throughout the world present a varied cross section of current state of the art techniques and advances in satellite dynamics technology. For instance, there are several papers reporting new investigations of the motion of artificial satellites about its center of mass in addition to atmospheric influence on the motion of artificial satellites. There are numerous papers relating recent advances in the state of the art of orbit determination theory and its role in the improvements of the current estimates of such physical parameters as planetary masses, coefficients of zonal harmonics in the geopotential and the gravitational field of the moon to name a few. There are papers or abstracts (of papers to be published elsewhere) of studies of the motion of artificial satellites of Mercury and Venus and the use of Brown's Lunar Theory to improve the orbit prediction of lunar satellites. Finally, there is a paper by W. G. Melbourne of the Jet Propulsion Laboratory which reviews the recent progress in the determination of the masses of terrestrial planets through radio tracking information from space probes and from a planetary radar measurements.

The book represents an excellent collection of papers that the reviewer feels is necessary reading for any serious researcher in the field of satellite dynamics. The collection contains information of a tutorial nature for newcomers to the field in addition to current state of the art results and techniques for the already initiated. Although naturally suited as a reference book, it should be useful as a supplementary textbook for graduate level courses in astrodynamics.

William R. Wells
Dept. Aerosp. Engr.
Univ. Cincinnati,
Cincinnati, Ohio

STABILITY OF A FOUR-BAR LINKAGE WITH FLEXIBLE COUPLER
Smith, M.R. and Maunder, L.
J. Mech. Engr. Sci. 13(4), 237-242 (Aug. 1971)

Refer to Abstract No. 72-129

A stability analysis is performed on a particular Hill's equation which describes the transverse vibration of the elastic coupler of a crank and rocker linkage. The authors have addressed a problem of growing concern in an age of high speed machinery, where elastic vibration can have drastic effects.

A partial differential equation of motion for the deflection of the coupler under transverse and longitudinal inertia forces is obtained from linear beam theory. Separation of variables and expansion by normal modes leads to a set of time-dependent Hill's equations. An analysis, restricted to the case of the fundamental mode of coupler vibration, yields approximate stability charts in terms of parameters relating crank speed, link lengths, follower inertia and coupler properties. A set of charts of this type may be a useful asset to the designer, providing guidelines for avoiding possibly undesirable designs.

However, the authors make some assumptions which may not always be justified. It is assumed that the crank and follower are rigid, when, in fact, they may be elastic resulting in coupled equations of motion. Thus, a logical extension would be to consider all the links to be elastic. Secondly, nonlinear terms in the equation of motion were assumed to be small and neglected.

George N. Sandor,
J. Peter Sadler and Imdad Imam
Mach. and Struct. Div.
Rensselaer Polytech. Inst.
Troy, N.Y. 12181

AN EXACT ANALYSIS OF FREE VIBRATIONS OF SIMPLY-SUPPORTED VISCOELASTIC PLATES
Srinivas, S. and Rao, A.K.
J. Sound and Vib. 19(3), 251-259 (Dec. 8, 1971)

Refer to Abstract No. 72-448

The authors set up and solve for the free vibrations of a simply-supported viscoelastic rectangular plate. They solve the resulting characteristic equation by computer and compare their results to thin plate theory and Mindlin's work. They conclude that: (1) thin plate theory overestimates the oscillatory and damping components of the eigenfunctions, and that this discrepancy increases with plate thickness, and (2) Mindlin's theory predicts flexural frequencies quite accurately.

Joseph Genin
School of Aeron., Astron. and Engr. Sci.
Purdue Univ.
Lafayette, Ind. 47907

NONDESTRUCTIVE TESTING OF WEAPON EFFECTS ON COMBAT AND LOGISTICAL VEHICLES
Johnson, R.L.; Leete, J.H.; O'Keefe, J.D.; and Tedesco, A.N.
Shock and Vib. Bull. 42(3), 149-157 (Jan. 1972)

Refer to Abstract 72-237

The use of sacrificial plates attached to the armor of combat vehicles is suggested as a nondestructive means of evaluating optical or electronic subsystems subjected to the shock environment of projectile impacts. This process limits the destructive plastic deformations to an additional attached plate thereby preserving the primary armor structure of the vehicle with resulting cost savings.

The use of an empirical approach is employed to demonstrate the similarity between measured shock environments with and without the added sacrificial plate. Initial testing was conducted in the laboratory using a 3/8 in. sacrificial plate bolted to a 0.40 in. test plate and subjected to 22 cal projectiles. Final tests were conducted on an M60A1E1 turret using 20 and 57 mm AP projectiles.

The results of both the laboratory and field tests show a surprising degree of similarity between the results with and without the additional plate. The accelerometer data presented appear similar to the extent that might be expected from one test to another against identical targets. Strain gage data show a more detectable difference with

direct impact results containing larger magnitudes of high frequency components. Differences between semiconductor and foil type strain gage results from the laboratory tests (attributed by the authors to intimacy of contact) are by far the most significant. Because of the lack of analysis of these data it is not possible to determine if the differences between strain gage types are totally explained by a larger magnitude of high frequency components as stated. There is evidence that the direct impact does result in increased high frequency amplitudes.

The authors note that a statistical evaluation has not yet been attempted nor has an analysis been performed to determine the expected deviation due to the presence of the plate. Such additional investigations are required before sacrificial plate test results can be meaningfully interpreted to obtain design environments.

However, based on the data available, the user of the sacrificial plate seems to provide a viable approach to quality control testing of mechanical, optical, and electronic subsystems at the system level of assembly. The resulting shock environment would be sufficiently realistic to provide an operational acceptance test without the excessive cost of damage to the parent vehicle.

Ralph E. Deitrick
Hughes Aircraft Co.
El Segundo, Calif.

ERROR BOUNDS FOR EIGENVALUE ANALYSIS BY ELIMINATION OF VARIABLES
Geradin, M.
J. Sound and Vib. 19(2), 111-132
(Nov. 22, 1971)

Refer to Abstract No. 72-303

The "reduction of variables" techniques aim at reducing the order of the general algebraic eigenproblem,

$$Kx = \lambda Mx \qquad (1)$$

without affecting too much the lower portion of the spectrum λ. The essence of these techniques, which can be regarded as a combination of the method of finite elements, the classical method of Ritz and the power method, consists of selecting a rectangular matrix T such that T^TKT and T^TMT are reduced as far as possible but with the lower spectrum of

$$T^TKTy = \lambda T^TMTy \qquad (2)$$

still near enought to that of Eq. (1). Evidently, the best choice for the columns of T are the eigenvectors of Eq. (1) since then the system is reduced by the corresponding eigenvalues remain unchanged.

Not knowing the exact eigenmodes, one may introduce into T some approximations that will be able to represent with some acceptable accuracy the eigenvectors one wants to compute. The prevelent reduction techniques consist of choosing the columns in T to be the elastic responses to unit forces distributed over the structure. This is, however, just one step in the power method. Indeed, if P denotes the load matrix for the point forces, then

$$T = K^{-1}MP \qquad (3)$$

and the application of K^{-1} to MP reduces in its expansion the components in the higher eigenmodes. If K is singular, instead of a response to unit forces these methods suggest for T the response to unit displacements.

Engineers find these reduction methods attractive since they leave space for skill and insight (in selecting P) but involve an automatic improvement step (the multiplication of P by K^1M).

In simple problems, it is questionable whether it is more economical to lay a fine mesh of finite elements and to reduce the matrix, then to generate smaller matrixes from a coarser mesh. In complex structures, however, a coarser mesh inevitably means a coarser idealization and there the reduction techniques may have merit.

Most of the paper by Geradin is devoted to a detailed analysis and review of previous works on this subject. For bounding the eigenvalues in the original unreduced problem, in order to estimate a posteriori the error committed in the reduction, he proposes to use the bounds due to Kato and Temple instead of those due to Krylor and Bogolinov proposed in earlier publications. Geradin also describes a computational technique which is applied to an idealized delta wing.

Isaac Fried
Dept. Math.
Boston Univ.
Boston, Mass. 02215

EXPLOITATION OF CU-RICH DAMPING ALLOYS -- PART 1: THE SEARCH FOR ALLOYS WITH HIGH DAMPING AT LOW STRESS
Bowie, G.E.; Nachman, J.F.; and Hammer, A.N.
ASME Paper No. 71-Vibr-106

Refer to Abstract No. 72-370

The paper is an outcome of combined efforts by the authors for the search of high-damping capacity alloys at low stress amplitudes. This provides a vital information toward the use of new high-damping capacity alloys for vibration and noise control of structures and machines. The use of bimetallic combinations of Mn-Cu high damping alloy bonded with high strength alloy is expected to find wide application. Investigation for finding temperature stable alloys at service temperatures, leading to the discovery of improved Mn-Cu-Cd alloys has been reported.

Determination of the use of cadmium modified manganese copper, solar HH series alloys (new Mn-Cu-Al) and Nivco (Ni-Co alloy) for damping the low-stress amplitude vibrations has been suggested by the authors.

N. T. Asnani
Dept. Mech. Engr.
Univ. Birmingham
P. O. Box 363
Birmingham B15 1TT, U.K.

PARAMETRIC VIBRATIONS IN A SINGLE-STAGE SPUR GEAR TRANSMISSION
Davydov, I.Sh.
Russian Engr. J. 50(10), 36-40 (1970)

Refer to Abstract No. 71-1350

Single-stage spur gear excitation results from the variable stiffness of engagement and the stiffness of the bearings. An analysis is developed, which is based on the following assumptions: (1) the engagement stiffness is a square wave: (2) the bearing stiffness is the total stiffness including bending compliance of shafts, radial compliance of bearings and their housings, compliance of the mating parts of the gearbox housing; (3) there is no break of contact either in the engagement or in the bearing; (4) dissipation is neglected; (5) the system development is ideally accurate; and (6) all other machine components are neglected.

Three, coupled, second order, linear equations of motion are derived for the idealized system above. Their solutions describe the motion of the gear shaft in the plane of the bearing and incorporate motion due to the elasticity of the engagement. This variable elastic engagement factor results in the conclusion that periodic excitation cannot be eliminated by choice of the bearing stiffnesses. The author proposes that the bearing stiffnesses may be balanced against the engagement stiffness in magnitude and phase, and the natural frequencies of the system are, in theory, constant; However, there appears to be no practical reason to do it.

The paper would be of interest to engineers concerned with dynamic problems of gear design. The analysis is, however, elementary and the extent to which the problem modeling describes an important, realistic problem is not at all clear.

C. D. Mote, Jr.
Dept. Mech. Engr.
Univ. Calif.
Berkeley, Calif. 94720

LARGE AMPLITUDE VIBRATIONS OF A RIGIDLY CLAMPED CIRCULAR PLATE
Huang, C.L. and Sandman, B.E.
Intl. J. Nonlinear Mech. 6(4), 451-468 (Aug. 1971)

Refer to Abstract No. 71-1551

In this paper, the nonlinear vibrations of a clamped circular plate are considered by assuming that: (1) the normal stresses in the transverse direction are negligible; and (2) the slopes produced by flexure are moderately large, but small in comparison to unity. Further, the nonlinearity is assumed to be geometric and no physical nonlinearity has been considered, i.e., the Hooke's law is taken to be valid. The author used Von Karman's dynamical equations (by neglecting the longitudinal inertia) to describe the large amplitude axisymmetric oscillations of a circular plate with a clamped and immovable boundary. Steady state sinusoidal vibrations are assumed, and the time variable is eliminated by applying a Kantorovich averaging method. Thus, the basic governing equations for the problem are reduced to a pair or ordinary differential equations, which form a nonlinear eigenvalue problem. This nonlinear eigenvalue problem is solved numerically by considering the related initial value problem.

The present problem has been solved previously by several authors including Nowinski, who used the Von Karman's dynamical equations in combination with an orthogonalization procedure. In the present work, the author showed that his results for free vibrations are in excellent agreement with the free resonance curve given by Nowinski. In the case of free vibrations, the familiar hard-spring behavior has been evidenced by a decrease of period with increasing amplitude. The influence of large amplitudes upon the transverse shape of vibration is illustrated. The nondimensional graphs of radial stress vs amplitude are also plotted. For the induced stresses, a behavior which is similar to that found by Way for the static equilibrium problem is found. The forced response of the plate under several different distributions of sinusoidal input is also investigated.

S. S. Rao
Dept. of Mech. Engr.
Indian Inst. Tech.
Kanpur-16, U.P. (India)

VIBRATION AND STABILITY OF A UNIFORMLY CURVES TUBE CONVEYING FLUID
Chen, S.S.
Acoust. Soc. Am. 51(1), 223-232 (Jan. 1972)

Refer to Abstract No. 72-648

An inextensible tube segment with a constant radius of curvature conveys a steadily flowing fluid. For in-plane motion, free vibration frequencies and conditions for buckling instability are derived. Results are presented for hinged-hinged, fixed-fixed, and fixed-hinged end conditions, in terms of dimensionless system parameters including flow velocity, tube curvature and arc length, unit masses of tube and fluid, tube stiffness, and fluid pressure.

Although the techniques of analysis are well known, the paper is expecially useful because of its excellent presentation of the governing equations and its clear interpretation of the numerical results. As the author correctly points out, some recently published results on a similar problem are invalid because certain terms in the governing equations were omitted. The present paper corrects these errors and concludes that buckling instability can occur for the fixed-fixed tube for both symmetric and asymmetric modes.

Minor typographical errors are: a plus sign is omitted in Eq. (3); and the first reference 21 should be 20.

The paper may be quite useful to pipeline designers, especially to those concerned with long curved pipelines used to gather oil from offshore installations.

James F. Wilson
Duke Univ.
Durham, N.C. 27706

A NEW ON-LINE DIGITAL DAMPOMETER FOR FREE-OSCILLATION STUDY
Fiquet, J.; Dupé, J.; and Combet, P.
Intl. Cong. Instrum. Aerosp. Simulation Facilities (June 21-23, 1971)

Refer to Abstract No. 72-51

Measuring the free decay of a natural mode oscillation is a widely used technique to determine damping in vibratory systems. Usually, free decay damping values are obtained by measuring and determining the ratios for successive peaks on an oscillograph record of a motion transducer output from the system under study. The natural logarithm of this ratio is then divided by the number of cycles separating the peaks to obtain a logarithmic decrement from which the damping factor can be determined. The number of cycles between peaks can be chosen as small, to that several damping values can be obtained from one decay record to determine amplitude dependency, or large, to obtain an average which decreases error caused by small decay rates and experimental inaccuracy. This method of data reduction is very tedious. In the past, some instruments for semiautomatically calculating damping values directly from transducer signals have been developed. However, as far as this reviewer is aware, none are commercially available today.

This paper describes a new digital system which provides automatic on-line readout of damping values during a free decay test. The system takes a signal from any type of transducer (acceleration, displacement, stress, etc.), rectifies it, integrates it over a preset (even) number of half-periods, p, logarithmically amplifies the integrated value, and stores it in memory. It then waits a preset number of half-periods, n, and repeats the operation. The two values

obtained are then operated on mathematically to obtain the damping factor, α, according to the equation

$$\alpha = \frac{\log_{10} I_0 - \log_{10} I_n}{n \log_{10} e}$$

where I_0 and I_n are the stored data values (e.g., if an accelerometer is used for data pickup, these values would represent velocities). This equation implies only two assumptions: (1) that the damped frequency equals the undamped natural frequency; and (2) that the damping is linear. Neither of these assumptions is restrictive for small damping (i.e., α < 0.2 or less), and hence, theoretically, the system should provide excellent results for both linear and nonlinear damping measurements within the stated range of $0.0001 \leq \alpha \leq 0.1$.

Operationally, the system has several convenient features. It has digital data readout, it can be preset to ignore the first cycles of an oscillation to eliminate transients, and it can provide two types of continuing measurements -- computing damping based on either I_n / I_0 or I_{r+n} / I_r where r is continually increasing. This last feature allows a choice between upgrading the average value during linear damping tests or determining instantaneous values as a function of amplitude in nonlinear tests. The system electronics limit the useful frequency range of the system to 500 Hz but are stated to present no problem near 0 Hz.

This system should provide considerable time saving and test flexibility to anyone who must make free decay damping measurements on a regular basis. Commerical availability of the system and patent status are not mentioned in the paper. It appears to be comprised of readily available components and anyone with a working knowledge of digital logic circuits can probably construct it if necessary and or legally permissible.

Brantley R. Hanks
NASA-Langley Res. Ctr.
Hampton, Va.

ON THE FINITE DEFLECTION DYNAMICS OF THIN ELASTIC BEAMS
Lee, S.Y.
J. Appl. Mech., Trans. ASME 38(4), 961-963 (Dec. 1971) 9 refs

Refer to Abstract No. 72-561

The dynamic theory of beams undergoing large deflection but small strain has been formulated by different authors. In this paper the author includes the effects of shear deformation and axial tension. Six first order quasi-linear nonhomogeneous partial differential equations are developed. Under certain conditions, these equations are fully hyperbolic. The properties of these equations are discussed in terms of three characteristics of disturbance propagation. The first two types of characteristics are found to correspond to the classical uniaxial and bending wave speeds in the beam theory. The third characteristic (C_c) discloses an important physical implication between the beam theory and the flexible string theory. It governs changes in transverse velocity and configuration. When the net axial tension is negligible (C_c) reduces to the classical shear wave speed in the beam theory. If the shear deformation is ignored (C_c) reduces to the classical wave speed in the flexible string theory. By discarding the derivatives of the stretch, the author shows that the governing six first order equations can be combined to yield a Timoshenko beam equation in the dependent variable (θ) which is the angle of orientation of the middle beam surface. For finite deflections the angle (θ) is not related to the linear displacement by a simple relation. An assessment of jump relations in hyperbolic systems associated with the first two types of characteristics leads the author to conclude that geometric nonlinearities, associated with large deflection, do not affect the linearity of the uniaxial and bending wave speeds.

M. F. Massoud
Université de Sherbrooke
Sherbrooke, Que., Canada

ON THE OSCILLATORY MOTIONS OF TRANSLATING ELASTIC CABLES
Simpson, A.
J. Sound and Vib. 20(2), 177-189
(Jan. 22, 1972) 8 refs

Refer to Abstract No. 72-632

The configuration studied in this work is an elastic catenary constrained to vibrate in plane motion. The catenary is assumed to be uniformly translating between two fixed end supports; thus, the configuration is a model of one link of an overhead cable conveyer system. Both longitudinal and transverse inertia are accounted for in the study; only free vibrations about the static equilibrium position are discussed.

The initial section of the paper presents a standard derivation of the cable equations; attention is restricted to the case of small linear motions about an initially deformed configuration (however, the static deformation pattern at the outset is not necessarily the result of a linear analysis). The resulting field equations are presented in terms of the independent unstretched cable length coordinate S_0; an alternate set of equations, in terms of the statically deformed cable length parameter S, is also presented. The static deformation loading function is restricted to a gravitational effect and the dependent deformations are the horizontal displacement u (longitudinal) and the vertical displacement v (transverse) representing small departures from the static equilibrium state.

The main purpose of the study is to obtain analytical solutions to the derived equations in order to conduct a parameter study of the effects of cable stiffness and translational speed on resonant frequencies. Hence, at the outset certain assumptions are made to render the derived equations amenable to a relatively closed form solution. The restrictions needed are: (1) small strains in the statically deformed configuration, and (2) shallow cable.

The second assumption effectively restricts the static deformation to be a small deviation from the initial unstretched position and is accompanied by the assumption that the cable tension remains constant during the static deformation process. This latter restriction is probably reasonable for the cable loaded by its own weight as long as the initial tension is large compared to the increment of tension increase during the static deformation process.

With the above assumptions, the problem reduces to the study of two coupled linear second order homogeneous differential equations in u(s,t), v(s,t). The equations have coefficients reflecting the effect of the small initial deformation and the effect of the uniform translational velocity. Due to the initial deformation, the equations contain some variable coefficients in the space coordinate; however, a simple transformation involving auxiliary variable reduces the equations to a semicoupled set of equations with constant coefficients which is amenable to standard analysis to obtain the resonant frequency parameter.

The solutions of these equations obtained are exact for the problem considered; it is shown in the text how further assumptions enable a relatively simple formula to be evolved for the lowest frequencies. It is also shown that the solutions reduced to the initially straight stretched string case and yield the familiar frequency results.

Numerical results are presented for a catenary of sag/semi span ratio = 0.1 for a variety of cable stiffnesses and various rates of translation. The results are obtained using the determinental equation evolving from the exact solution; for the lowest frequencies, some results are obtained using the simple approximative formulas and show excellent agreement with the more exact solutions.

Results for mode shapes are given indicating the distortion caused by the translational velocity.

The author claims that his results should be of use to conveyer belt designers and to those engaged in research into the aeroelastic instability of overhead conveyer systems. The reviewer is of the opinion that while the paper is a good one, the restriction to plane motions might restrict the applicability of the results. One may need to consider the effect of out-of-plane nonlinear whirl motions which are known to occur near cable resonances. It is not clear at this point what the interactions between initial deformation (even if small, but finite), translations at uniform speed, and nonlinear motions might lead to in the way of design requirements.

A. I. Soler
The Towne School of Civil and Mech. Engr.
Univ. Pa.
Philadelphia, Pa. 19104

A GENERALIZED FORMULATION OF THE VECTORIAL EQUATIONS OF MOTION FOR NONPRISMATIC THIN SPACE BEAMS
Massoud, M. F.
J. Appl. Mech., Trans. ASME 38 (4), 955-960 (Dec. 1971) 6 refs

Refer to Abstract No. 72-562

The author presents a formulation of generalized vectorial equations of motion for small vibrations of any nonprismatic thin space beam. The equations are given in terms of a linear displacement vector and a rotational displacement vector. Boundary conditions in terms of these vectors are discussed. Equations for several specific cases, that of a plane curve, a circle, a catenary, an involute, and a helix are explicitly given. It is noted that inplane curves the equations are not coupled. The effects of shear deformation and rotary inertia are briefly discussed. The equations developed are valuable in studying the dynamics of flexible transmission shafts and satellite antennas.

S. Y. Lee
Univ. Iowa
Iowa City, Iowa

CALENDAR

Meeting	Date 1972	Location	Contact
	AUG.		
National West Coast Meeting, SAE	21-24	San Francisco, Calif.	A. J. Favata, SAE Hq.
6th International Conference on Nonlinear Oscillations, Acad. Sci. USSR, Czech. Acad. Sci., German Acad. Sci., Polish Acad. Sci.	29-4	Poznan, Poland	Polish Acad. Sci., Inst. Fundamental Tech. Res., Organizing Committee of the 6th Intl. Conf. Nonlinear Oscillations, Warsaw, Swietokrzyska 21, Room 334, Poland
Applied Mechanics Western Conference, ASME	29-31	Honolulu, Hawaii	A. B. Conlin Jr., ASME Hq.
	SEPT.		
National Combined Farm Construction and Industrial Machinery and Powerplant Meeting, SAE	11-14	Milwaukee, Wis.	A. J. Favata, SAE Hq.
	OCT.		
National Aeronautic and Space Engineering and Manufacturing Meeting, SAE	2-6	San Diego, Calif.	A. J. Favata, SAE Hq.
International Conference on Noise Control Engineering, INCE	4-6	Washington, D.C.	M.J. Crocker, R.W. Herrick Labs., School Mech. Engr., Purdue Univ., Lafayette, Ind. 47907
12 US Mechanisms Conference, ASME	8-11	San Francisco, Calif.	A. B. Conlin Jr., ASME Hq.
Industrial and General Applications Group Annual Meeting, IEEE	9-12	Philadelphia, Pa.	J. A. Herrmann, ITE Circuit Breaker Co., 1900 Hamilton St., Philadelphia, Pa. 19130
Joint Lubrication Conference, ASME, ASLE	9-12	New York, N.Y.	ASME Hq.
Symposium for Gearing and Transmissions, IFToMM, ASME, AGMA	11-12	San Francisco, Calif.	A.I.Tucker, Mail Zone C-3, Solar Div., Intl. Harvester Co., 2200 Pacific Hwy., San Diego, Calif. 92112
Annual and National Environmental Meeting, ASCE	16-20	Houston, Tex.	Meetings Manager, ASCE Hq.
Fall Meeting, SESA	17-20	Seattle, Wash.	B. E. Rossi, SESA Hq.
	NOV.		
16 Stapp Car Crash Conference, Wayne State Univ., Univ. Mich., SAE, Univ. Calif.	8-10	Detroit, Mich.	A. J. Favata, SAE Hq.
Winter Annual Meeting, ASME	12-16	New York, N.Y.	A. B. Conlin Jr., ASME Hq.
Fall Joint Computer Conference, AFIPS	14-16	Las Vegas, Nev.	D. R. Cruzen, AFIPS Hq.
Fall Meeting, ASA	27-1	Miami Beach, Fla.	M. Kronegold, Inst. Marine Sci., Rickenbacker Causeway, Miami, Fla. 33149
	DEC.		
75th Anniversary Meeting, ASTM	3-5	New Orleans, La.	H. H. Hamilton, ASTM Hq.
43rd Shock and Vibration Symposium	5-7	Asilomar, Calif.	Shock and Vibration Information Center, Washington, D.C. 20390
	1973 JAN.		
Automotive Engineering Congress and Exposition, SAE	8-12	Detroit, Mich.	A. J. Favata, SAE Hq.
6th Conference on Applications of Simulation, IEEE	17-19	San Francisco, Calif.	L. W. Heinle, Lockheed M&S Co., 170 San Pablo Ave., San Francisco, Calif. 94127
1973 Annual Reliability and Maintainability Symposium, AIAA	23-25	Philadelphia, Pa.	D. Wendling, AIAA Hq.
	MAR.		
Dynamics Specialist Conference, AIAA	19-20	Williamsburg, Va.	Meetings Manager, AIAA Hq.
Structures and Materials Conference, AIAA/ASME/SAE	19-23	Williamsburg, Va.	Meetings Manager, AIAA Hq.
14th Structures, Structural Dynamics and Materials Conference, AIAA, ASME, SAE	20-23	Williamsburg, Va.	Meetings Manager, AIAA Hq.
International Convention and Exhibit, IEEE	26-29	New York, N.Y.	J. M. Kinn, IEEE Hq.
19th Annual Technical Meeting and Equipment Exposition, IES	31-4	Anaheim, Calif.	Betty L. Peterson, IES Hq.
	APR.		
Annual Structural Engineering Meeting, ASCE	9-13	San Francisco, Calif.	Meetings Manager, ASCE Hq.
Spring Meeting, ASA	10-13	Boston, Mass.	J. A. Swets, 50 Moulton St., Cambridge, Mass. 02138
Joint Railroad Technical Conference, IEEE, ASME	11-12	St. Louis, Mo.	IEEE Hq.
Design Engineering Conference and Show	23-26	New York, N.Y.	A. B. Conlin Jr., ASME Hq.
American Power Conference, IIT	24-26	Chicago, Ill.	R. A. Budenholzer, Dir. APC, IIT
	MAY		
International Congress on Experimental Mechanics, SESA	13-18	Los Angeles, Calif.	B. E. Rossi, SESA Hq.
National Automobile Meeting, SAE	14-18	Detroit, Mich.	A. J. Favata, SAE Hq.
Spring Joint Computer Conference, AFIPS	15-17	Atlantic City, N.J.	H. G. Asmus, AFIPS Hq.
27th Annual Technical Conference, ASQC	21-23	Cleveland, Ohio	R. W. Shearman, ASQC Hq.
16th ISA Power Instrumentation Symposium, ISA	23-25	Chicago, Ill.	A. Watson, Westinghouse Electric Corp., 10 S. Riverside Plaza, Chicago, Ill. 60606
Canadian Congress of Applied Mechanics (CANCAM)	28-1	Montreal, Canada	A. Biron, CCCCAM Hq.

CALENDAR

Meeting	Date 1973	Location	Contact
	JUN.		
Lubrication Symposium, ASME	June	New Orleans, La.	A. B. Conlin Jr., ASME Hq.
Summer Annual Meeting, ASME	10-13	Philadelphia, Pa.	A. B. Conlin Jr., ASME Hq.
14th Joint Automatic Control Conference, AIAA, AIChE, ASME, IEEE	20-22	Ohio State Univ. Columbus, Ohio	H. R. Weed, Dept. EE, Ohio State Univ., Columbus, Ohio 43210
Applied Mechanics Conference, ASME	20-22	Atlanta, Ga.	A. B. Conlin Jr., ASME Hq.
76th Annual Meeting and Exposition, ASTM	24-25	Philadelphia, Pa.	H. H. Hamilton, ASTM Hq.
	AUG.		
National West Coast Meeting, SAE	20-23	Portland, Ore.	A. J. Fava'a, SAE Hq.
Applied Mechanics Western Conference, ASME	29-31	Honolulu, Hawaii	A. B. Conlin Jr., ASME Hq
	SEPT.		
Vibrations Conference, ASME	16-19	St. Louis, Mo.	A. B. Conlin Jr., ASME Hq
	OCT.		
Environmental Engineering Meeting, ASCE	Oct.	New York, N.Y.	ASCE Hq.
International Electrical, Electronics Conference and Exposition, IEEE	Oct.	Toronto, Canada	A. J. Dinnin, Chairman, Toronto Sec., c/o Bell Telephone Labs., Rm. 402, 393 University Ave., Toronto, Can.
Joint Lubrication Conference, ASLE, ASME	14-18	Atlanta, Ga.	ASLE Hq
1973 Fall Meeting, SESA	16-19	Indianapolis, Ind.	B. E. Rossi, SESA Hq.
Fall Meeting, ASA	30-2	Los Angeles, Calif.	R. Stern and W. Meecham, U. of Calif., Los Angeles, Calif., 90024
	NOV.		
Winter Annual Meeting, ASME	11-15	Detroit, Mich.	A. B. Conlin Jr., ASME Hq.
Fall Joint Computer Conference, AFIPS	13-15	Las Vegas, Nev.	H. G. Asmus, AFIPS

ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

AFIPS: American Federation of Information Processing Societies
210 Summit Ave., Montvale, N.J. 07645

AGMA: American Gear Manufacturers Association
1330 Mass. Ave., N.W., Washington, D.C.

AIAA: American Institute of Aeronautics and Astronautics
1290 Sixth Ave., New York, N.Y. 10019

AIChE: American Institute of Chemical Engineers
345 E. 47 St., New York, N.Y. 10017

ARPA: Advanced Research Projects Agency

ASA: Acoustical Society of America
335 E. 45 St., New York, N.Y. 10017

ASCE: American Society of Civil Engineers
345 E. 47 St., New York, N.Y. 10017

ASME: American Society of Mechanical Engineers
345 E. 47 St., New York, N.Y. 10017

ASNT: American Society for Nondestructive Testing
914 Chicago Ave., Evanston, Ill. 60202

ASQC: American Society for Quality Control
161 W. Wisconsin Ave., Milwaukee, Wis. 53203

ASTM: American Society for Testing and Materials
1916 Race St., Philadelphia, Pa. 19103

CCCCAM: Chairman, c/o Dept. ME, Univ. Toronto,
Toronto 5, Ontario, Canada

IEEE: Institute of Electrical and Electronics Engineers
345 E. 47 St., New York, N.Y. 10017

IES: Institute Environmental Sciences
940 E. Northwest Highway, Mt. Prospect, Ill. 60056

IFToMM International Federation for Theory of Machines and Mechanism
US Council for TMM, c/o Univ Mass., Dept ME,
Amherst, Mass. 01002

INCE: Institute of Noise Control Engineering

ISA: Instrument Society of America
400 Stanwix St., Pittsburgh, Pa. 15222

ONR: Office of Naval Research
Code 400B4, Dept. Navy, Arlington, Va. 22217

SAE: Society of Automotive Engineers
2 Pennsylvania Plaza, New York, N.Y. 10001

SEE: Society of Environmental Engineers
68a Wigmore St., London W1H 9DL, England

SESA: Society for Experimental Stress Analysis
21 Bridge Sq., Westport Conn. 06880

SNAME: Society of Naval Architects and Marine Engineers
74 Trinity Pl., New York, N.Y. 10006

URSI-USNC: International Union of Radio Science - US National Committee
c/o MIT Lincoln Lab., Lexington, Mass. 02173

CONTENTS